

APPENDICES

APPENDIX A

RADIOLOGICAL SITE AND BACKGROUND INVESTIGATION SAP

FIELD SAMPLING PLAN

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RADIOLOGICAL SITE AND BACKGROUND INVESTIGATION

FIELD SAMPLING PLAN

Revision 2

FINAL

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FIELD SAMPLING PLAN

APPROVAL SHEET

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ATTACHMENTS

Attachment A	Standard Operating Procedures
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ACRONYMS AND ABBREVIATIONS

A/Ts	Agencies and Tribes
BRA	Baseline Risk Assessment
COPC	Contaminant of Potential Concern
CVAA	cold vapor atomic absorption
DQOs	Data Quality Objectives
DSR	Data Summary Report
DVS	Data Validation Summary
e.g.	<i>exempli gratia</i> (Latin, for example)
EDD	Electronic data deliverable
ERG	Environmental Restoration Group
FCR	Field Change Request
FS	Feasibility Study
FSP	Field Sampling Plan
FTL	Field Team Leader
ft	Foot or feet
ft ²	Square feet
GPS	Global Positioning System
HASP	Health and Safety Plan
HPIC	High Pressure Ionization Chamber
ICPMS	Inductively coupled plasma/mass spectrometry
i.e.	<i>id est</i> (Latin, that is to say; in other words)
K-40	Potassium-40
MARSSIM	Multi-Agency Radiation Survey and Site Investigation Manual

m ²	Square meter
MWH	MWH, Inc. (formerly Montgomery Watson Harza, Inc.)
NESHAPS	National Emission Standards for Hazardous Air Pollutants
P4	P4 Production, L.L.C.
pCi/m ² s	Picocurie per square meter per second
QAPP	Quality Assurance Project Plan
QA/QC	Quality Assurance/Quality Control
Ra-226	Radium-226
RI	Remedial Investigation
SAP	Sampling and Analysis Plan
Sites	Collectively the Ballard, Henry and Enoch Valley mine sites
SOP	Standard Operating Procedure
Th-232	Thorium-232
USEPA	United States Environmental Protection Agency

1.0 INTRODUCTION

This Field Sampling Plan (FSP) details the scope of field work proposed for the collection of radiologic and soil data in suitable background locations and at the former P4 Production L.L.C. (P4) mine sites (the Sites). This FSP is Appendix A to the *Radiological and Background Investigation Sampling and Analysis Plan* (SAP). The Quality Assurance Project Plan (QAPP) is Appendix B of the SAP and provides the detail regarding the analysis of samples collected as described in the FSP. Section 2.0 and Table 2-1 of the SAP presents the Data Quality Objectives (DQOs) that have been developed to provide the rationale for the sampling program and guide the sample collection and analysis program presented in this FSP. Specific health and safety considerations are necessary for the work activities proposed during this upcoming investigation. An activity hazard analysis has been prepared to define specific health and safety concerns during the proposed field program and is included in Appendix C of the SAP. The MWH field team will review the activity hazard assessment before conducting the work presented in this FSP. The more extensive Health and Safety Plan (HASP) for the Remedial Investigation/ Feasibility Study (RI/FS) field activities is provided in Appendix E of the *RI/FS Work Plan*.

The remainder of the FSP is organized as follows:

- Section 2 – Background Information and Objectives, provides a brief summary of background information related to the need for the radiological and background investigation, and objectives for the proposed sampling effort.
- Section 3 – Sampling Rationale and Approach, includes the processes to be used for selection of sample locations and rationale for their selection.
- Section 4 – Sampling Equipment and Procedures, includes the methods and procedures that will be used to collect samples and decontamination procedures that will be performed during the field sampling activities.
- Section 5 – Sample Handling, includes discussions of sample designation, handling, and shipping.

- Section 6 – Documentation and Records Requirements, details the various field forms, field change requests, and chain-of-custody records to be completed for the project.
- Section 7 – Project Organization, presents the project team, schedule, and deliverables.
- Section 8 – References.

2.0 BACKGROUND INFORMATION AND OBJECTIVES

This section briefly provides the supporting information and rationale for why the radiological and background investigations are necessary at this time. Additional program background and objective details are provided in Sections 1.1 and 1.2 of the SAP.

Uncertainties related to the assessment of background constituent levels and overall Site risks associated with uranium and other constituents of potential concern (COPCs) are significant, and to evaluate risks properly, additional data are required as discussed in Sections 1 and 2 of the SAP. To accomplish the objectives described in the SAP, P4 will collect: (1) representative radiological measurements, both On-Site and in appropriate background locations (where representative radiological measurements and soil samples have not been collected), and (2) supplemental background data for chemical COPCs in soil primarily over the members of the Phosphoria Formation (i.e., the Rex Chert/cherty Shales Members and Meade Peak Member).

These data will be used to put human health risk estimates calculated for the Ballard Mine, and presented in the *Ballard RI Report*, in appropriate context during preparation of the Ballard Mine FS, and to calculate more representative human health risk estimates for radiogenic and metal/metalloid COPCs during preparation of the Baseline Risk Assessment (BRA) for the Enoch Valley and Henry Mines. Such evaluations will then account for the naturally elevated background concentrations of uranium and other COPCs found in representative background areas and at the Sites but not represented accurately in the Ballard BRA as previously discussed (please refer to Sections 1 and 2 of the SAP).

This FSP details the proposed equipment, methods and procedures that will be used to collect the above data in the selected Background and On-Site Areas.

3.0 SAMPLING RATIONALE AND APPROACH

The sampling activities necessary to meet the sampling objectives described in Section 1.2 of the SAP are outlined in this section. In the two selected Background Areas, sampling will be conducted to collect radiologic and soil COPC data. On-Site, only radiologic measurements/correlation samples need to be collected because soil COPC data were previously collected. The equipment and procedures necessary to collect these data are detailed in Section 4.0 of this FSP. Detailed rationale for the proposed sampling is discussed in Section 1.2 of the SAP.

3.1 Background Areas

3.1.1 Sampling Locations and Rationale

Soil samples and radiological measurements will be collected in Background Areas. The criteria used for identifying appropriate background areas include:

- An area (or areas) where the full stratigraphic section, which represents a typical mine area and layout, is present.
- Similar to mined areas, but in an undisturbed condition.
- Physical accessibility of land in the vicinity of the Sites that is owned or leased by P4.

Representative areas in both Caldwell Canyon and Blackfoot Bridge were selected for use in the background study primarily because they have geology and stratigraphy that is directly comparable to what was found at the Sites prior to mining, and these areas appear to be accessible by truck or on foot. In addition, P4 currently holds the mining lease for these properties and property access is allowed. The possible survey/sampling areas within the Caldwell Canyon background reference area are shown on Figures 2-3 to 2-5 of the SAP (i.e., the primary and alternate areas depicted on the map). The possible survey areas within the Blackfoot Bridge background reference area are shown on Figures 2-7 to 2-9 of the SAP (i.e., the primary and alternate areas depicted on the map). These areas are representative of

the typical width of a phosphate mine footprint such as the Henry or Enoch Valley Mines (approximately 1,000 to 2,000 feet [ft] from the ridge to the valley below).

MWH will conduct reconnaissance of the two possible survey locations within the Caldwell Canyon and Blackfoot Bridge locations and choose which one to use in each location based primarily on the terrain and geology as described in Section 4.2.

3.1.2 Sampling Approach

The sampling activities conducted in the Background Areas for collection of field radiologic and COPC data will include the following steps. Figure 2-6 of the SAP depicts the plan view of the selected Caldwell Canyon area and presents graphically and in Legend descriptions the procedures that will be employed to collect radiological measurements and soil samples in this Background Area.

- 1) Conduct reconnaissance of two survey units (primary and alternate) at both of the Caldwell Canyon and Blackfoot Bridge areas, choose the one (primary or alternate) to use based on access, terrain (field conditions), and geology. Refer to Figures 2-3 and 2-7 of the SAP for the locations of the primary and alternate areas at Caldwell Canyon and Blackfoot Bridge.
- 2) Once the background area is selected, conduct a GPS-based scanning gamma survey on foot over the entire ~800 ft x 2,500 ft background reference area by establishing transect lines oriented perpendicular to the geologic bedding with a 100-foot spacing between the lines). The same procedures used in the Caldwell Canyon Background Area will be repeated in the Blackfoot Bridge Background Area (refer to Figure 2-6 of the SAP). Note: If elevated gamma readings occur when scanning the Wells Formation within the Blackfoot Bridge primary survey area (due to proximity of J.R. Simplot operations), then scanning and sampling of the Wells Formation in the alternate area will be performed.
- 3) Select a single line of transect across the Background Area that is oriented perpendicular to the geologic units (based on geology and information from Steps 1

and 2) that will be used to collect samples in Steps 4 and 5, below. Based on understanding of the major geologic units, anticipate that there will be four survey areas corresponding to the four geologic units in the Background Area. Note that in Figure 2-6 only the Rex Chert sampling event is depicted and there will be three others in the other geologic units. Geologic units in the areas include the (1) uppermost Wells Formation, (2) Dinwoody Formation, and (3) the Meade Peak and (4) Rex Chert/Cherty Shale Members of Phosphoria Formation (the Rex Chert and Cherty Shale Members are grouped together as one unit) which represent the areas either mined or covered by mine waste rock at the Sites. The survey lines (areas) will be chosen based on (1) the gamma survey results, which should clearly show the Meade Peak Member's upper and lower contacts and (2) favorable field conditions including: changes in the dominant formation (i.e., formation contacts), vegetation coverage (areas with sparse of trees/scrubs cover would be desired), accessibility by all-terrain vehicles, etc. The transect survey lines crossing areas that are overly steep or have bedrock outcrops will be avoided.

It is assumed that most areas will contain locally-derived colluvial soils, which are representative of the Sites in a pre-mined or native condition. No attempt will be made to specifically separate colluvial from in-place soils. In addition, soil samples will not be collected within 50 feet of the geologic contact between the Rex Chert Member and the Meade Peak Member due to uncertainty with the contact.

However, the contact between the Wells Formation and Meade Peak Member is generally identifiable due to the resistant nature of the Grandeur Tongue Formation; however, if this formation is not identifiable or if a test pit cannot confirm the contact, a 50 foot buffer may also be applied if there is uncertainty with the location of the contact. Soil samples also will not be collected from rock outcrops themselves, but the in-place, colluvial soils that overlie each of the formations.

- 4) **Radon Flux Measurements:** In each Background Area, along the transect established in Step 3, a minimum of 15 activated charcoal radon flux canisters (randomly located) will be installed and retrieved from each of the four survey areas for a total of 60 locations at sampling nodes (points).

- 5) **Soil COPC Sampling:** In each of the Background Areas, the geologic units to be sampled for soil COPCs will include: (1) the Meade Peak Member of the Phosphoria Formation, (2) the Rex Chert/Cherty Shale Members of the Phosphoria Formation, and (3) the Wells Formation. Background data for soil COPCs is available for the Wells and Dinwoody Formations from the 2009 Soil and Vegetation program (MWH, 2011 and MWH, 2013b). During the 2009 investigation, 20 soil samples were collected from the Dinwoody Formation and 10 soil samples were collected from the Wells Formation. In order to have a similar number of soil samples from each of the geologic units, 10 additional soil samples will be collected from the Wells Formation (5 soil samples from each Background Area); 20 soil samples will be collected from the Rex Chert Member (10 soil samples from each Background Area); and 20 soil samples from the Meade Peak Members of the Phosphoria (10 soil samples from each Background Area). Field personnel will collect composite soil samples from each of the geologic formations as detailed in Section 4.6.

This will result in the following:

- a. 20 soil samples from the Dinwoody Formation (collected in 2009, refer to paragraph below)
- b. 20 soil samples from the Meade Peak member of the Phosphoria Formation (collected in 2014)
- c. 20 soil samples from the Rex Chert/Cherty Shale Members of the Phosphoria Formation (collected in 2014)
- d. 20 soil samples from the Wells Formation (10 soil samples collected in 2009 and 10 soil samples collected in 2014)

In addition, P4 will collect ten (10) additional samples from the Dinwoody Formation using the same sampling procedures as used for the samples listed above. Five (5) samples will be collected at each of the background areas. These samples will be used for qualitative comparison to the previous Dinwoody Formation samples collected the Henry and Enoch Valley Mines. However, they will be

excluded from the new background data set in favor of the Henry and Enoch Valley samples collected in 2009 if there is no statistical difference

- 6) **Correlation Studies:** Correlation studies are necessary so that information collected through the GPS-based gamma survey can be translated to predicted exposure rates and Ra-226 and uranium concentrations for use in the risk assessments. In each of the two Background Areas, select a minimum of five locations spanning the range of count rates observed from the GPS-based gamma survey areas/units (i.e., the four geologic units depicted in Figures 2-3 and 2-7) and collect measurements for the correlations (i.e., a minimum of 10 total locations from the two Background Areas), as described below.
- 7) At each of the selected correlation locations:
 - a. Collect co-located direct gamma count (one minute integrated count) and exposure rate measurements made every six seconds for three minutes, using a high pressure ionization chamber [HPIC].
 - b. Conduct a GPS-based survey of a 1,075 square ft (ft²) (100 square meter [m²]) area and collect a five-point composite surface soil sample therein, for analysis of total uranium, radium-226 (Ra-226), potassium-40 (K-40), and thorium-232 (Th-232).

3.2 On-Site Areas

3.2.1 Sampling Locations and Rationale

Based on the discussion in Section 2.0, the existing radiologic data set in the On-site Areas is incomplete and collection of supplemental data is necessary to fill this data gap. As a result, additional data will be collected from selected areas within the Sites that include a variety of reclamation conditions on the waste rock dumps and encompass a range of potential radiological exposure (low, medium, and high) as described further below.

3.2.2 Sampling Approach

The sampling activities conducted in the On-Site Areas for collection of radiological data in the field include the following steps:

- 1) Conduct reconnaissance and a GPS-based gamma survey primarily over the disturbed portions (i.e., waste rock dumps) of each of the three mines (using a 200-foot spacing). Survey transects will extend approximately 200 ft off the waste rock dumps to confirm that the radiological materials are confined in and near the dumps and have not spread laterally. The GPS-based survey will be extended to encompass the horizontal extent of contamination, if warranted.
- 2) Define size and location of distinct survey areas based on the GPS-based gamma survey results and mines site conditions from Step 1. Anticipate, based on understanding of mine site reclamation, that there will be distinct survey areas among the Sites representing different mine reclamation conditions. Select a total of three survey units/areas throughout the Sites, as identified by the GPS-based gamma survey (low, medium, and high gamma count rates) for radon flux sampling and correlation studies. The survey areas may or may not include all three P4 Mine Sites (e.g., two survey areas at the Ballard Mine and one survey area at the Enoch Valley Mine). Figure 2-10 of the SAP depicts a hypothetical survey area or “unit” selected for investigation at the Enoch Valley Mine.
- 3) **Radon Flux Canister Sampling:** In each of the three major survey areas (low, medium, and high gamma count range) selected in Step 2, install and retrieve 15 randomly-located activated charcoal radon flux canisters per selected survey area (for a total of 45 radon flux measurements throughout the Sites).
- 4) **Correlation Studies:** Similar to the correlation studies in the Background Areas, select a minimum of 10 locations spanning the range of gamma count rates (low, medium, and high gamma count range) across the three selected units (identified in Step 2), then perform a GPS-based gamma survey and collect co-located gamma count and exposure rate measurements and five point composite soil samples for the correlations.

At each of these selected correlation locations:

- a. Collect co-located direct gamma count (one minute integrated count) and exposure rate measurements made every six seconds for three minutes, using a HPIC.
 - b. Conduct a GPS-based survey of a 1,075 ft² (100 m²) area and collect a five point composite surface soil sample therein, for analysis of total uranium, Ra-226, K-40, and Th-232.
- 5) No additional sampling for soil COPCs is proposed On-Site.

4.0 SAMPLING EQUIPMENT AND PROCEDURES

This section presents the site access, equipment, and procedures for the collection, handling, and analysis of each sampled medium. Samples will be analyzed according to the methods in Section 5.0 below. Where applicable, references to Standard Operating Procedures (SOPs) are provided.

4.1 Site Access, Logistics, and Safety

P4 has access to all of the areas where field activities are proposed; e.g., the background areas in Caldwell Canyon and Blackfoot Bridge and at the Sites. The A/Ts will be notified, at minimum, five business days prior to commencement of field activities. The MWH On-Site Safety Officer will notify the P4 Project Manager (Rachel Roskelley) a minimum of three days prior to working at a mine area. Such notification is needed to arrange for any company-specific safety training, and if necessary, to arrange for a company representative to accompany the crew to provide access to shop and equipment storage areas.

Any field equipment and samples will be stored at the Fox Hills Machine Shed, owned by P4. Equipment, supplies, samples bottles, etc. will be shipped to the Monsanto plant, in Soda Springs, in care of Rachel Roskelley (P4). Sample handling and shipment from Site is presented in Section 5.0.

Safety procedures for the site investigation are described in the HASP (Appendix E of the *RI/FS Work Plan*) and in the Activity Hazard Analysis for this Program (Appendix C of the SAP). The mine-specific safety requirements involve a short training orientation for hazard recognition and avoidance. In the event that P4's corporate safety policy is stricter than the requirements of the HASP, those corporate safety requirements will take precedence.

4.2 Reconnaissance Field Survey

A reconnaissance field survey will be conducted at both background locations and at the Sites.

4.2.1 Background Areas

The four identified potential Background Areas are representative of the typical width of a phosphate mine footprint such as the Henry or Enoch Valley Mines (approximately 1,000 to 2,000 ft from the ridge to the valley below). These areas also include the uppermost Wells Formation, the Phosphoria Formations, and the Dinwoody Formation. The criteria used for identifying appropriate background areas are discussed in Section 3.1. A reconnaissance field survey of two background areas (primary and alternate) within both of the proposed Caldwell Canyon and Blackfoot Bridge background areas will be conducted to decide which one (the primary or alternate) to use based on access, terrain, and geology.

The Field Team Leader (FTL) will walk the terrain in each background location to determine (1) the exact location of the rectangular areas shown on the figures referenced above and (2) where the GPS-based gamma surveys will be conducted. Following the initial survey of these areas, the FTL will discuss the layout with the MWH and P4 project managers. Any anomalies such as rock outcrops, and excessively steep areas will be identified and evaluated. Once the final area and orientation is agreed upon, it will be marked in the field with 3-foot long lath installed at regular intervals around the perimeter so that the radiological measurements discussed below can be made. The spacing of the lath will depend on the terrain and might range from a few hundred to less than 100 ft.

4.2.2 On-Site

A field survey, as discussed above in the potential background areas, will not be necessary at the Sites, but GPS-based gamma surveys will be conducted over the entirety of each of the Sites as discussed below. Based on that work, three representative areas (or units) within the collective Sites will be selected for radiological data collection as described below. It is assumed these areas will be representative of the various mine reclamation conditions (e.g., thickness of topsoil, soil/rock composition, rock type, age of reclamation, etc.) and encompass the range of gamma exposure rates.

4.3 GPS-Based Gamma Survey – Background and On-Site

For large areas, such as the Background and On-Site Areas, gamma emissions are best characterized by conducting GPS-based gamma surveys, in which gamma count rates and geopositions are measured and recorded in real-time while field personnel move across the site. The GPS-based gamma survey system will consist of a 2-inch by 2-inch Ludlum Model 44-10 NaI detector, coupled to a Ludlum Model 2221 ratemeter/scaler which, in turn, is linked to a Trimble PorXRS GPS. The surveys will be conducted along transects perpendicular to bedrock bedding planes (the strike of the bedrock) at a 100-foot spacing in the Background Areas and 200-foot spacing in the On-Site Areas. The gamma count rate measurements and associated differentially-corrected geopositions will be recorded every second.

Often the scale of radiological surveys (e.g., at the Sites) make their completion in a timely manner on foot difficult. At the Sites, because of the large areas to be surveyed and where site conditions will allow it, initially push carts or vehicles will be used. For areas that cannot be accessed by push carts or vehicles, then a backpack setup will be employed.

The GPS-based gamma surveys include the following steps, which are also detailed in the SOPs in Attachment A:

- Place the GPS units, camcorder batteries and Ludlum 2221 meters in the foam seat in the middle of the baby jogger.
- Mount the detectors onto the dedicated bracket attached to the push cart.
- Mount the GPS antennas to the crossbar directly above the detectors. Keep note that the antennas should be high enough that the line-of-site to satellites will not be blocked.
- Mount the Trimble TSCe data loggers to the crossbar.
- Attach each Trimble TSCe to its corresponding GPS unit and Ludlum 2221 RS232 serial port.

- Attach each detector to its corresponding Ludlum 2221 using a C-C cable.
- Attach the battery clips from each GPS unit to the camcorder batteries.

Daily function checks of the detection system(s) will be performed prior to and after each day's work or when problems are identified during each field day. Should there be any problems identified they will be corrected before continuing the survey.

It is important to achieve sufficient scanning coverage, such that there are no large voids in data without an explanation such as standing water or excessive vegetation. Excess readings are acceptable, but data that are too spatially dense may display poorly. Operations will be conducted as follows:

- Move the push cart to the area to be surveyed and turn on all survey equipment
- It is often helpful to have a background file placed on the TSCe to help ensure the proper area is surveyed. If a background file is loaded onto the TSCe, it will show up as a polygon in the map window and may be set to appear as a different color than the survey path.
- Begin surveying at 1 to 2 ft per second and cover the entire area as outlined by the background file. For the Sites, this primarily will be the reclaimed waste rock areas. In the background area this will be the area identified and flagged following the field survey as discussed above.
- At the end of each surveying day or as necessary, download the data from the data loggers.

At the completion of the GPS-based gamma scanning survey, one of the transect lines surveyed will be selected and used to collect the radon flux and COPC samples discussed below (refer to Figure 2-6 in the SAP). The line will be chosen in the field by the FTL based on (1) the gamma survey results, which should clearly show the Meade Peak Member's upper and lower contacts and (2) favorable field conditions including: readily identifiable changes in the dominant formation (i.e., formation contacts), vegetation coverage (areas devoid of

trees/scrubs would be desired), accessibility by all-terrain vehicles, etc. The transect survey lines crossing areas that are overly steep or have bedrock outcrops would be avoided.

4.4 Radon Flux Measurements

Fifteen activated charcoal radon flux canisters will be placed on each of the study areas/geologic units identified in both Background Areas (four geologic-formation study areas) and at the Sites (three study areas). The procedure for radon canister sampling has been written to comply with applicable National Emission Standards for Hazardous Air Pollutants (NESHAPS) regulations (40 CFR Part 61), which specify that Method 115, "Radon 222 Emissions from Uranium Mill Tailings Pile," or an equivalent method shall be used to demonstrate compliance with 40 CFR 61.

The Environmental Restoration Group (ERG) charcoal canister consists of a ten inch (in.) diameter cylinder open on one end and a vent hole and handle on the other end. The cylinder is filled with approximately 0.75 in. of activated charcoal (380 grams) divided into eight equal volume compartments and held in place with a metal screen and support. Measurements are made by placing the open end of the canister on the area to be characterized and allowing the collected radon to adsorb onto the charcoal. Upon retrieval in the field, the entire canister is sealed in a plastic bag and transported to the laboratory for gamma spectral analysis. Radon canister placement, in terms of the selection and numbers of locations, will vary between the Background Areas and the On-Site Location and is discussed below. The SOP for radon canister deployment and retrieval is presented in Attachment A.

4.4.1 Background Areas

In the Background Areas, a minimum of 15 activated charcoal radon flux canisters (randomly located) will be installed and retrieved in each of the four survey areas or units for a total of 60 canisters per Background Area. In each unit, there will be 15 sampling nodes (points) established along the transect line based on the GPS-based gamma survey results (refer to Figure 2-6 in the SAP). The transect will be perpendicular to the geologic bedding

and selected in the field by the FTL based on field conditions as discussed in Section 4.3. In each geologic unit to be sampled, ERG will:

- 1) Locate the beginning of the sampling transect 50 feet away from the Meade Peak/Rex Chert geologic contact. This is necessary to establish a buffer zone that allows for any uncertainty in this geologic contact. The field team will utilize a similar 50-foot buffer zone for the Meade Peak/Wells Formation and/or Rex Chert/Dinwoody formation contacts if not readily identifiable either through on-sight test pits or observations of key marker beds (e.g., the Grandeur Tongue Formation).
- 2) After the buffer zone (if necessary) is established, locate an initial sampling node for each survey area or unit by selecting a random point in first 25 ft of the sampling transect (i.e., where sampling is less likely to be physically obstructed by on-site trees and bushes).
- 3) Follow-up node spacing along transect = remaining geologic unit thickness ÷ 14 samples
- 4) Establish the actual sample location along a line 50 ft to either side of the node (i.e., parallel to the geologic bedding and perpendicular to the transect line); use random numbers generated by calculator/computer (i.e., a random number between 0 and 1 times 100 to get 0-100 ft). The 0-foot end of the perpendicular line will be at its left end when looking uphill, 50-foot mark will be the intersection with transect line, and the 100-foot mark will be at the far right end of this line.

4.4.2 On-Site

On-Site the radon canister placement will occur once the three areas (or units; low, medium, and high) are selected based on the GPS-based gamma survey as discussed in Section 3.2. In each unit to be sampled, ERG will:

- 1) Install and retrieve 15 randomly-located activated charcoal radon flux canisters per selected survey area/unit (for a total of 45 radon flux samples); the measurement

locations will be sited using a triangular, systematic grid with a random start point using the most current version of Visual Sampling Plan.

- 2) Divide each of these major survey areas into 15 approximately equal subareas by dividing the total area (ft²) by the number of samples to be collected (i.e., 15 samples).
- 3) In each of these 15 subareas, select a point randomly for sampling by: estimating the horizontal dimensions; randomly selecting x and y coordinates; and then verifying coordinates fall within the subarea.
- 4) Place radon flux canisters at each of the selected random locations within the 15 subareas.

The radon canisters will be collected after approximately 24 hours and transported to the ERG laboratory for analysis of radon-222.

4.5 Background Area - Soil COPC Sample Collection

Randomly located composite soils samples will be collected during this investigation. Composite soil samples for COPC analysis will be collected only in the Background Areas and from soils overlying the Wells Formation, Rex Chert/Cherty Shale Members of Phosphoria Formation and Meade Peak Member of the Phosphoria Formation. Composite soil samples also will be collected at each of the locations selected for radiologic correlation studies.

Soil samples representative of background conditions for select COPCs in soil will be collected in both of the Background Areas (Caldwell Canyon and Blackfoot Bridge). The geologic formations sampled for soil COPCs will include the Meade Peak and Rex Chert/Cherty Shale Members of the Phosphoria Formation (i.e., two members or strata) and the Wells Formation. Background data for soil COPCs is available for the Wells and Dinwoody Formations from the 2009 Soil and Vegetation program (MWH, 2013b); however, in order to have an equal number of samples from each geologic unit, additional samples are required from the Wells Formation.

The COPCs in the soil analyte list include: antimony; arsenic; boron; cadmium; chromium; cobalt; copper; manganese; mercury; molybdenum; nickel; selenium; silver; thallium; uranium; vanadium; and zinc. This is the same list of constituents that was analyzed for during the 2009 Soil and Vegetation study.

In each Background Area, 10 randomly-selected composite samples will be collected from each of the Phosphoria Formation geologic units (Meade Peak and Rex Chert) and five selected composite samples will be collected from each of the Wells Formation geologic units. So in each of the Background Areas there will be three strata sampled and a total of 25 composite soil samples collected for analysis (a total of 50 composite samples from the two Background Areas).

The soil sampling activities necessary in the Background Areas for collection of COPC soil samples include the following steps. Refer to Figure 2-6 in the SAP for an example of how this would be accomplished at a typical Background Area.

- 1) Use the same initial sampling node for each survey area as established for the radon measurements described above (including the potential for a 50-foot buffer zone prior to selecting an initial sampling node). The requirement for randomness is met because the initial sampling node is randomly selected.
- 2) Follow-up node spacing along transect equals the remaining geologic unit thickness divided by nine samples to generate a total of ten sampling nodes along the transect for the Rex Chert and Meade Peak. Divide by four samples to generate a total of five sample nodes along the transect for the Wells Formation.
- 3) Center a 50 x 50 ft quadrat on each of the sampling nodes. The field team will use a measuring tape and compass to form the 50 x 50 ft square area.
- 4) Each 50 x 50 ft quadrat sampling area is divided into 2,500 1-ft² sample locations. Five sample points are randomly selected in the field using the RAND() function in Excel to generate strings of grid coordinates ranging from 0 to 49. A table of random numbers may be generated for use in the field prior to the sampling event. Each number pair would be crossed out as it is used.

- 5) A discrete soil sample is collected from each of the five 1-ft² sample locations and composited to represent the area as described below.

Soil samples will be collected from each of the five randomly selected 1-ft² sample points. The soil sampling depth will be 0-6 inches and a decontaminated soil coring device or similar tool will be used to help ensure a consistent volume of soil is collected from each sample location.

As each of the five grab samples are collected, they will be placed into a clean stainless steel bowl. Large debris (including vegetation) will be removed, shaken lightly to dislodge adhered particles, then discarded. The soil in the bowl then will be mixed with a decontaminated stainless steel spoon or equivalent tool and passed through a 1/4-inch sieve. The material passing through the sieve will be transferred to two (or more) 16-ounce glass sample containers. Field sieving will reduce the quantity of material such that the entire sample can be submitted to the laboratory rather than field-compositing, splitting, and storing the remaining soil on site. Sample containers, preservation techniques, sample volumes, and holding time requirements are summarized in Table 2-1 of the QAPP (Appendix B of the SAP).

4.6 Correlation Studies – Background and On-Site

In each of the two Background Areas, select a minimum of five locations spanning the range of count rates observed from the GPS-based gamma survey areas/units (i.e., the four geologic units depicted in Figures 2-3 and 2-7 of the SAP) and collect measurements for the correlations (i.e., a minimum of 10 total locations from the two Background Areas). A minimum of 10 On-Site correlation studies are anticipated in areas identified in the GPS-based gamma survey (low, medium, and high), which likely represent different mine reclamation conditions.

Real-time radiological measurements (GPS-based gamma surveys, direct gamma counts, and exposure rates) as well as composite soil samples for total uranium and Ra-226 via chemical and gamma spectroscopy analyses will be collected at each of the locations: (1) for correlation purposes, (2) to confirm secular equilibrium, and (3) to improve the robustness

of the existing data sets. The gamma spectroscopy analysis also will yield K-40 and Th-232 concentrations in soil, which may be useful in evaluating anomalies in the spatial or frequency distribution of gamma count rates; and trends in the correlations between radionuclide concentrations and gamma emissions and therefore exposure rates..

Correlation studies are necessary so that information collected through the GPS-based gamma survey can be translated to Site-wide predictions of exposure rates and Ra-226 and uranium concentrations for use in the risk assessments.

The following activities will be conducted at each of the selected correlation locations.

Additional details on the correlation procedures are provided in the SOPs in Attachment A.

4.6.1 Co-located Direct (Static) Gamma Count and Exposure Rate Measurements

Co-located direct (static) gamma count and exposure rate measurements will be made at locations identified based on the GPS-based gamma survey results. The gamma count and exposure rate measurements will be made using a 2-inch by 2-inch Ludlum Model 44-10 NaI detector coupled to a Ludlum Model 2221 ratemeter/scaler and GE GS-131 HPIC, or their equivalents, respectively. One-minute (integrated) gamma count rate measurements will be made with the detector held vertically at approximately 18 inches above the ground surface at each location, with the meter in scaler mode. The exposure rate measurements will be made 1) with the base of the HPIC set at 1 meter and 2) every six seconds for three minutes. Measurements will be made according to the methods presented in Attachment A.

4.6.2 GPS-Based Gamma Surveys and Composite Soil Sampling –

GPS-based gamma surveys and composite soil sampling will be conducted at each of the locations to develop a correlation between Ra-226 concentrations in surface soil and gamma count rates. The effort will be conducted over a 1,075 ft² (100 m²) area, conducted using the same detection system and in the same manner as those in Site-wide and Background Area surveys, but along transects spaced five feet (5) apart.

The random soil samples will be comprised of a five-point composite at each of the corners and center of each 1,075 ft² areas in accordance with the SOP in Attachment A. The soil sampling depth will be 0-6 inches and a decontaminated soil coring device or similar tool will be used to help ensure a consistent volume of soil is collected from each sample location. The sets of the averages of the GPS-based gamma count rates and their associated Ra-226 concentrations in each 1,075 ft² area will be correlated, using the linear regression feature of MS Excel, or equivalent.

As each of the five grab samples are collected, they will be placed into a clean stainless steel bowl. Large debris (including vegetation) will be removed, shaken lightly to dislodge adhered particles and discarded. The soil in the bowl then will be mixed with a decontaminated stainless steel spoon or equivalent tool and passed through a 1/4-inch sieve. The material passing through the sieve will be transferred to two (or more) 16-ounce glass sample containers. Field sieving will reduce the quantity of material such that the entire sample can be submitted to the laboratory rather than field-compositing, splitting, and storing the remaining soil on site. Sample containers, preservation techniques, sample volumes, and holding time requirements are summarized in Table 2-1 of the QAPP (Appendix B of the SAP). The correlation soil analyte list is uranium, Ra-226, K-40, and Th-232.

4.7 Surveying

All measurements will be referenced to the State Plane Coordinate System Idaho East, North American Datum 1927. Each soil sampling location will be located using a hand-held GPS.

4.8 Equipment Decontamination

Equipment used for collecting samples will be decontaminated prior to all sample acquisition activities. Sampling equipment (including shovels, trowels, etc.) will be cleaned and decontaminated prior to use and between each sampling location. Equipment will be decontaminated as follows:

- Remove any excess rock fragments, soil, and vegetation from the sampling equipment
 - Wash the equipment in non-phosphate detergent (e.g., Crystal White, Alconox® or Liqui-Nox® solutions made as directed by the manufacturer)
 - Rinse with potable water
 - Rinse twice with deionized water
 - Allow equipment to air dry

All decontamination water will be discharged to the land surface.

5.0 SAMPLE HANDLING

This section presents the procedures for handling the samples once they have been collected and includes the labeling (designation), shipping, analysis and handling of the data generated from the analyses.

5.1 Sample Designation

Samples will be labeled with all necessary information on laboratory supplied labels using waterproof ink. Pre-printed labels will contain the following information:

- Site location
- Sample identification
- Method of preservation, if used
- Sample matrix

The date and time of sample collection and sampler's initials will be added to the label at time of collection.

Each sample will be assigned a unique identification number. This number will be coded according to sample location according to the following format for soil samples:

AABB-MXX- bbaa-YY-c

where:

- **AA** indicates the year (two digits) the sampling event started
- **BB** indicates the month (two digits) the sampling event started
- **M** designates "Monsanto" and is used to denote data collected for Monsanto (P4) mine specific investigation and to differentiate it from historic area-wide sampling.
- **XX** indicates the specific mine or background areas

- BK: Background Area
- OS On-Site Area
- BF: Blackfoot Bridge Background Area
- CC: Caldwell Canyon Background Area
- **aa or bbaa** denotes the specific station number/location
- aa for sequential numbers 01 through 10
- bb for geological units within the background areas
 - DW: Dinwoody Area
 - MP: Meade Peak
 - RC: Rex Chert
 - WF: Wells Formation
- **YY** denotes the type of sample
 - SSfor a soil sample
 - RN for a radon sample
- **c** denotes the duplicate or replicate number (if left blank it indicates that no replicate samples were taken; if there are Quality Assurance/Quality Control (QA/QC) replicate samples, then 1 is used and represent the duplicate or replicate samples).

As an example, sample number **1407-MBF-RC01-SS** describes a non-duplicate, composite surficial soil sample collected at Monsanto’s Blackfoot Bridge background area from the Rex Chert in July of 2014.

For equipment rinsate samples, the number will be identified as **AABB – ER – ZZ – bb**

AA:	Indicates the year (two digits) the sampling event started
BB:	Indicates the month (two digits) the sampling event started
ER:	Equipment Rinsate
ZZ:	Media type (SS for surficial soil, RN for radon)
bb:	Rinsate number (01, 02, 03,.... etc.)

5.2 Field Equipment, Sample Handling and Shipping

Prior to sample collection, the field crew will ensure that adequate quantities of the following supplies and consumables are available in the field:

- Sample containers (per Table 2-1 of the QAPP, Appendix B of the SAP), temperature blanks, and coolers
- Ice
- Rinsate water
- Personal protective equipment (e.g., gloves, suits, hard hats)
- Camera for photodocumentation
- Field notebooks
- Field forms (e.g., chain-of-custody, soil sampling logs)

Sample containers as provided by the laboratory will be placed on ice in an insulated cooler to $4 \pm 2^{\circ}\text{C}$. Insulated coolers will be provided by the contract laboratories or purchased locally. All samples will be stored in the coolers and handled as specified in the QAPP (Appendix B to this SAP). All samples will remain in the coolers until the end of the day when all of the samples are shipped to the laboratory.

Samples will be shipped to the laboratories with blue ice or bagged standard ice in coolers with custody seals placed on the outside of the coolers (i.e., bridging the lid with the cooler side). Each cooler will be secured with packing tape and shipped via overnight Federal Express service to the appropriate laboratory. If possible, only one type of medium will be shipped in each cooler. MWH will fill out appropriate chain-of-custody forms supplied by the respective laboratory. The chain-of-custody will be included with the sample shipment, and copies of all chains-of-custody along with Federal Express waybills will be kept by MWH field personnel.

Samples will be sent to ALS Environmental at the following address:

ALS Environmental
225 Commerce Drive
Fort Collins, CO 80524
(970) 490-1511 (phone)
(970) 490-1522 (fax)
Attn: Sample Receiving (Amy Wolf)

Supplies including sample containers and coolers will be sent to the Monsanto Plant:

Monsanto Company
1853 HWY 34
Soda Springs, ID 83276
(208) 547-1439
Attention: Rachel Roskelley

5.3 Sample Analysis

The target analyte lists for soil (and water equipment rinsate) samples are as follows:

- Antimony, arsenic, boron, cadmium, chromium (total), cobalt, copper, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc by inductively coupled plasma/mass spectrometry (ICP/MS), USEPA Method 6020A.
- Mercury by cold vapor atomic absorption (CVAA), EPA Method 7471A (by USEPA Method 7470A in water)

- Ra-226, K-40, and Th-232 by gamma spectroscopy, USEPA Method 901.1M (by USEPA Methods 903.1 and 901.1, respectively, in water).

5.4 Field Quality Control Samples

Field duplicates for each matrix will be collected at a rate of ten (10) percent of the number of primary samples, and matrix spike and matrix spike duplicate pairs will be collected at a rate of five (5) percent of the number of primary samples. One equipment rinsate will be collected each day of sampling. In the instances where equipment rinsates need to be collected, one source water sample will be collected for the entire field event.

6.0 DOCUMENTATION AND RECORDS REQUIREMENTS

6.1 Field Logbooks

Sample collection activities including radiological measurements will be documented in permanently bound, page-numbered, weather-resistant field logbooks assigned to the FTL, or, if multiple sampling teams are used, to a designee in charge of each team. Each notebook will be identified to the project, task, and to the individual assigned custody of the logbook. For all sampling to be performed, the appropriate SOP, appended to the FSP, will also be employed. If logbook custody is transferred to another individual, such transfer will be noted in the logbook and signed and dated by both parties. All entries will be made in indelible ink; errors will be corrected by one single line through the text being revised, and all such corrections will be initialed and dated.

With the exception of the information contained in the appropriate SOP, governing the media to be sampled, bound field logbooks will be used to record the following information, as appropriate for the type of sampling being performed:

- Date, time, subjects, and attendees of daily tailgate training sessions
- Sample date, time, types, numbers, and quantities
- Sample container preservation steps performed
- Sample locations, including GPS coordinates
- Numbers of associated photographs, with appropriate cross-references to the affected camera
- Sampling equipment used
- Decontamination steps performed
- Acknowledgements that chain-of-custody forms and express shipment information were properly completed

In addition, other ancillary information will be recorded, including:

- Time of arrivals/departures of MWH personnel and/or other visitors to the sampling site(s)
- Weather conditions
- Presence of livestock or wild game
- Time and subject of any incoming or outgoing telephone/radio contacts
- Any unusual events

The logbooks will be kept up to date on a daily basis; backup copies of each day's entries will be made on a weekly basis and forwarded separately to the project quality records, in addition to copies of all outgoing chains-of-custody and sample shipping documents.

6.2 Field Forms

In addition to the field logbooks, field forms will be required to be filled out by the sampling team conducting the sampling. All efforts will be made to fill out the information at the sampling location. Field forms for the sampling activities are used to supplement the field logbooks. The appropriate forms are located in the applicable SOP (provided in Attachment A of this FSP).

6.3 Chain-of-Custody Records

Documentation of sample custody must be maintained from the time the soil samples are collected through: receipt at the destination laboratory; sample homogenization, preparation, and analysis; data recording and reduction; data validation; and final release of laboratory analytical data. Initial information concerning sample collection will be recorded in the field logbook as described in Section 3.5.1. Information on the custody, transfer, handling, and shipping of samples will be recorded by field personnel on a project-specific chain-of-custody form for the laboratory(ies) being utilized for the analyses. A chain-of-custody form

will be completed for each set of samples collected daily and will contain the following information:

- Sampler's signature and affiliation
- Project name and identification number
- Date and time of collection
- Sample identification number and matrix
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping papers/waybill identification number (e.g., Federal Express tracking number as identified on pre-printed packing labels)

A copy of each as-transmitted chain-of-custody form will be retained in the project records.

6.4 Documents and Records

Documents and records are defined as completed, legible documents which furnish objective evidence of the items or services, activities affecting quality or the completeness of data, and which are maintained for the specific project. These records will be organized and managed in MWH's program office and will include, at a minimum, the following:

- Original and backup copies of all bound field logbooks
- Field copies and original (laboratory) copies of all chain-of-custody documents

- Personnel training records (except that any medical monitoring program will be maintained in MWH's personnel files)
- Incoming and outgoing project correspondence (letters, telephone conversation records, faxes, and hard copies of e-mail messages)
- Copies of all laboratory agreements and amendments thereto
- Purchasing records for project supplies
- As-received laboratory data packages (hard copy and electronic data deliverable [EDDs])
- Validated laboratory data packages
- All approved Field Change Request (FCR) forms
- Draft and final versions of all reports and any associated presentation materials
- Draft and final delivered versions of the RI reports and its supporting procedures

6.5 Field Change Request Forms

Due to the conditions associated with field sampling activities, unexpected situations may occur that will require deviations or modifications to the requirements of the SAP. Other changes may be required by P4 during the course of this project. In such situations, the Program Manager may authorize the FTL or designee to undertake SAP modifications, provided that the scope of such modifications is discussed with the program Quality Manager and the EPA Project Manager and approved beforehand by both the program Quality Manager and EPA Project Manager. For significant changes, the EPA Project Manager should consult with the A/T before providing approval. Any modification to the SAP, FSP, or QAPP will be documented on a FCR form. Each FCR will be uniquely numbered and will identify the project and task, the affected sections of the SAP or its supporting procedures, the scope of the requested variation, and the justification for its acceptance. At the Program Manager's discretion, the FCR may be forwarded to appropriate

P4 representatives for review purposes prior to implementation. The field team leader will update field personnel of any changes.

6.6 Reports to Management

The FTL will summarize the daily sampling activities in a Daily Team Leader Progress Report form. This form requires the input of the following information:

- Date activities occurred
- Identification of the field team leader and all other field sampling personnel
- Identification of subcontractors and visitors
- Summary of the work accomplished
- Identification of work planned or expected but not accomplished
- Description of activities planned for the next day of sampling

The daily progress report form is due to the P4 and MWH Project Managers at the end of day.

6.7 Training Requirements

MWH field personnel will be trained in the requirements of the SAP in a project meeting prior to the initiation of field activity. All personnel will read the SAP documents prior to the start of field work, and will acknowledge completion of training at the time of the project meeting. Meeting notes and attendance sheets will be kept and forwarded to the project records. In addition, prior to conducting each day's sampling activities, the Field Team Leader, or designee will conduct a "tailgate" meeting with field staff to review field procedures and sampling requirements, in order to better ensure that samples are collected and handled according to FSP and QAPP requirements. Tailgate meeting discussion subjects and attendees will be documented in the Field Logbook.

The FTL will maintain a hard copy of the current approved version of the entire SAP for ready-reference in the field vehicle or field office. Additionally, each field team will have a hard copy of the SAP.

7.0 PROJECT ORGANIZATION

7.1 Project Team

Figure 1-1 of the *RI/FS Work Plan* presents the organization of the entire RI/FS project team. Contact information for each member of the project team for implementation of this SAP is presented in Table 7-1. The Background and On-Site field work will be performed by ERG and MWH as described below:

- MWH will provide oversight of the radiological surveys performed by ERG at both the Background and On-Site Areas.
- MWH will assist ERG with collection of radiological samples including radon and correlation samples at both the Background and On-Site Areas.
- MWH will collect the surface soil COPC samples from the Background Areas.

The MWH field team leader will submit a daily update to P4 and MWH project and task managers that contains a report of daily progress, any variances from planned work for the day, anticipated work for the next day, and any other problems or assistance required. A weekly update will be submitted to the A/T on-scene coordinator. All updates will be submitted via e-mail.

7.2 Project Schedule

- It is anticipated that the investigation will occur in Summer 2014
- Data validation – within 60 days of receipt of laboratory data

7.3 Project Deliverables

While this SAP is intended to help guide a specific investigation at the study locations, this investigation is supplemental to the overall Sites RI/FS. It is anticipated that the data collected as part of this investigation will be presented in a Data Summary Report (DSR) and

utilized as part of the Ballard Mine FS process as well as in the individual RI Reports and risk assessments for Henry and Enoch Valley Mines. The raw data and data validation reports will be submitted to the A/T upon request when available. A data validation summary (DVS) consisting of validated data tables will be submitted to the A/Ts within approximately 120 days from the date of collection of the last sample from this field program.

TABLES

**TABLE 7-1
PROJECT CONTACTS**

Company or Agency	Contact	Title	Telephone
P4 Production	Rachel Roskelley	Special Project Lead— Mining / Program Manager	208-547-1248
USEPA	Dave Tomten	Remedial Project Manager	208-378-5763
MWH	Vance Drain	MWH Project Manager	801-617-3250
	Betty VanPelt	Project Chemist	801-617-3243
	Emily Jackson	On-Site Safety Officer/ Field Team Leader	801-617-3232
	Celeste Christensen	Project Coordinator	425-896-6969
ALS Environmental	Amy Wolf	Project Manager (primary laboratory)	970-490-1511
Laboratory Data Consultants, Inc	Linda Rauto	Project Manager (data validation subcontractor)	760-634-0437

ATTACHMENT A

STANDARD OPERATING PROCEDURES

STANDARD OPERATING PROCEDURE 1.13
HIGH PRESSURE IONIZATION CHAMBER SETUP AND OPERATION

1. PURPOSE

The purpose of the procedure is to instruct the user on how to properly setup and operate a High Pressure Ion Chamber (HPIC) to make gamma radiation exposure measurements

2. DISCUSSION

This procedure applies to the GE-Energy (formerly Reuter-Stokes) HPIC Model RSS-131, or equivalent.

3. PROCEDURE

3.1 Equipment

3.1.1 High Pressure Ion Chamber and tripod.

3.1.2 Cable.

3.1.3 Computer.

3.2 Setup

3.2.1 Load the RSS-131 software to laptop or desktop using the provided CD

3.2.2 Connect HPIC to laptop using RS232 cable.

3.2.2.1 Connect round 8-pin connector to COM Port 4 on HPIC

3.2.2.2 Connect DB-9 serial connector to COM 1 on computer.

3.2.3 Open RSS-131 Configuration Utility on computer.

3.2.3.1 From the configuration Utility you can change the HPIC settings such as logging time, format, etc. Refer to the RSS-131 manual for more details.

3.3 Operation

3.3.1 The HPIC logs reading whether or not it is connected to a computer. You can turn the detector on/off as needed between locations.

3.3.2 When the HPIC is initially turned on, the exposure rate readings will spike. After approximately 2-3 minutes the readings will have stabilized.

3.3.3 After the stabilization period, the HPIC will continue to collect readings according to the logging settings. The collection period should be defined by project specific instructions.

3.3.4 At each location, the date, location, collection start and stop time should be noted in the field log book.

3.4 Downloading data

3.4.1 Upon completion of data collection, the data can be downloaded to a computer.

Connect the PC to the HPIC according to section 3.2 or the HPIC User's Manual.

3.4.2 Open the Utility program, from the Online menu select the 'Upload sensor data from RSS-131' option. The data can be downloaded in .csv format. The data can be viewed, managed and displayed in Microsoft Excel.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the HPIC and associated computer program utilities.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and/or electronic files and stored with field notebooks and/or equipment folders or files.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 No Attachments.

Author's Signature:	Reviewed By:
<i>Charles P. Farr</i>	<i>Kenneth R. Baker</i>

STANDARD OPERATING PROCEDURE 1.30

FUNCTION CHECK OF EQUIPMENT

1. PURPOSE

To describe the procedures for operational check-out and function check of radiation detectors and meters prior to collecting data.

2. DISCUSSION

The site manager is responsible for assuring that this procedure is implemented. The survey team members are responsible for following the procedure. It is imperative that the equipment is properly function checked each day of use and documented.

3. PROCEDURE

3.1 Equipment

3.1.1 Ratemeters and/or Scalars including Ludlum Models 2221, 2241, 3, 12, 19, 2360, or equivalent

3.1.2 Detectors including Ludlum models 44-10, 44-9, 44-2, 44-116, 43-5, 43-89, 43-93, or equivalent

3.1.3 Cable: C-C or other connectors, as applicable

3.1.4 Record Forms: ERG Form 1.30A (single channel detector) or 1.30B (dual channel detector)

3.1.5 Radiological check sources, typically Th-230 (alpha), Tc-99 (beta), and/or Cs-137 (gamma) sources

3.1.6 Calibration Jig

3.1.7 Instrument Manuals

3.2 Initial Instrument Field Check Out.

3.2.1 The following instructions should be followed unless otherwise directed by Project Manager.

3.2.2 Create a Function Check Form for each piece of equipment being used. Record serial numbers, calibration dates, and check source information in the appropriate fields. Under comments, record source to detector distance, site name, and location on site where function check is performed.

3.2.3 Check the instrument to assure that the settings are consistent with the calibration data. This means the Battery, High Voltage, Threshold, and Window Settings must be set

according to those used in the original calibration or set up. Check with the Project Manager if in doubt or if changes are necessary for site specific reasons.

3.2.4 Replace the batteries in the meter if they indicate that they are near the low voltage level. Record all settings including the battery voltage on the Function Check Form.

3.2.5 With the meter in the rate meter position and a meter scale selected so that the meter is not pegged (other than the log scale), move both ends of the detector cable to determine if the cable is functioning properly. A faulty cable will introduce spurious counts. To test a cable, move both ends of the cable watching the meter. If excessive counts occur the cable may be faulty. Replace with a new cable of identical size and repeat the test. Document faulty cable and dispose of cable.

3.2.6 Select a location to perform the function check. This location should be selected with the following conditions in mind:

3.2.6.1 The location should represent background conditions for the site.

3.2.6.2 The radiological conditions surrounding the location should be expected to remain consistent throughout the duration of the project.

3.2.6.3 This will be the location that all function and source checks will be performed at the beginning of the work day and the end of the work day for the duration of the project.

3.2.7 With the detector placed in the fixed geometry position with no radioactive check source present, perform 1-minute scaler count and record the background count rate on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.8 Repeat the 1-minute scaler counts with the radioactive check source in place. Record the results on the Function Check Form. Unless directed otherwise by the Project Manager, repeat until ten background readings are recorded.

3.2.9 With Project Managers assistance determine the acceptable daily function check range. Typically this range will be the average of the initial ten counts plus or minus ten percent.

3.3 Daily Function Check.

3.3.1 The daily function check is typically performed twice daily, once before work activities have commenced and a second time when work activities have been completed. Follow steps 3.3.3 – 3.3.6 below for each time a function check is performed. If equipment is used for only a brief period of time, less than 1 hour, then a single daily pre-operations function check may be necessary.

- 3.3.2 Create a Daily Function Check form for each piece of equipment being used as described in 3.2.2 above. In the comments field note that the form is being used as a daily function check form.
- 3.3.3 Follow steps 3.2.3 – 3.2.5 above.
- 3.3.4 Measure the background count for one minute (unless otherwise directed by project manager) at the previously identified function check location (see 3.2.6 above). Record on the Daily Function Check form.
- 3.3.5 Repeat 3.3.4 with the check source in place. If the detector is dual channel (alpha/beta) then repeat again with the second source in place.
- 3.3.6 If the daily function check results do not fall within the acceptable daily function check range, as discussed in Section 3.2.9 above, check the source, geometry and immediate area to determine if anything may have caused the check to fail. If a reason is found attempt to fix the problem. Count again. If the daily function check results in a second failure remove the instrument from service and report the event to the Project Manager.

4. TRAINING

- 4.1 Prior to performance of calibrations or use in the field, all personnel must show proficiency in the operation of the detectors and meters being utilized.
- 4.2 Prior to use in the field, all personnel must show proficiency in use of the function check forms.
- 4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

- 5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)
- 5.2 Computer generated files will be saved as hard copies and stored with instrument folders and/or project files.

6. REFERENCES

- 6.1 Project personnel using this procedure should become familiar with the contents of the following documents:
- SOP 4.03
- Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 1.30A – Function Check Form (Single Channel)

7.2 Form 1.30B – Function Check Form (Dual Channel)

Author's Signature:	Reviewed By:
<i>Charles P. Farr</i>	<i>Kenneth R. Baker</i>

STANDARD OPERATING PROCEDURE 2.07
DEPLOYMENT OF RADON-222 FLUX CANISTERS

1. PURPOSE

Provide instructions for measuring Radon-222 (Rn-222) flux from ground or tailings surfaces.

2. DISCUSSION

Rn-222 is an inert radioactive gas with a half-life of 3.8 days. Radon flux from soils is a measure of the potential buildup of radon in structures that may be placed on the soil. For remediated uranium mill tailings piles, regulations (10 CFR Part 40, Appendix A and 40 CFR Part 192) limit the radon flux to 20 pCi/m²s. Additional potential applicable regulations include the National Source and Hazardous Air Pollutant Standards (40 CFR Part 61). The National Emission Standards for Hazardous Air Pollutants (NESHAP) regulations (40 CFR part 61) specify that Method 115, "Monitoring for Radon-222 Emissions" or an equivalent method shall be used to demonstrate compliance with 40 CFR 61. This procedure has been written to comply with all requirements in Method 115.

The ERG charcoal canister consists of a ten inch (in.) diameter right circular cylinder open on one end and a vent hole and handle on the other end. The cylinder is filled with approximately 0.75 in. of activated charcoal (380 grams) divided into eight equal volume compartments and held in place with a metal screen and support. Measurements are made by placing the open end of the canister on the area to be characterized and allowing the collected radon to adsorb onto the charcoal. Upon retrieval, the entire canister is sealed in a plastic bag and transported to the laboratory for gamma spectral analysis.

A sodium iodide gamma-ray spectrometer is used to measure the amount of Rn-222 adsorbed to the charcoal by measuring the 609 keV gamma ray emitted by its Bi-214 daughter. A minimum of 4 hours from the end of the collection period is necessary to allow the Bi-214 to come into equilibrium.

The calculations convert the activity on the charcoal to an average flux, considering the parameters, canister area, collection time, time from end of collection to the beginning of counting, and counting time. The bag is not to be opened or removed from the canister until after

the count is made to assure that any desorbed radon will be collected and counted along with that on the charcoal.

3. PROCEDURE

3.1 Equipment

- 3.1.1 Charcoal canisters sealed in plastic bags.
- 3.1.2 Extra plastic bags.
- 3.1.3 Waterproof ink pen.
- 3.1.4 Record Forms: ERG Form 2.07 or equivalent
- 3.1.5 Watch.
- 3.1.6 Hand trowel.
- 3.1.7 Cloth or paper towels.

3.2 Pre-Deployment

- 3.2.1 Prior to deployment, bake the canisters at 100 degrees Celsius for 24 hours or longer. Place and seal canisters in plastic bags. Use the specially designed shipping cartons.
- 3.2.2 Review the Data Acceptance Criteria 3.5 before deploying canisters. Do not deploy if the criteria are not met.

3.3 Deployment

- 3.3.1 Upon arrival at the place of deployment, carefully open the shipping cartons being careful not to damage or destroy the cartons or spacers as they are necessary for returning the canisters to the laboratory. Remove the ERG numbered canisters from the shipping boxes. Document any evidence that a bag may have been punctured during shipping. Do not use any canisters from bags that were punctured prior to deployment.
- 3.3.2 Take the canister out of its plastic bag as it is deployed. The canisters should be deployed over the area to be characterized using an evenly spaced grid pattern. The canister shall be placed on a fairly level flat surface. Place loose soil void, not tailings, around the outside of the canister for a proper seal. A small hand trowel shall be used to assist in this task. One hundred points for each area should normally be selected. Record the canister number, location, deployment time, and date.
- 3.3.3 Determine if and how many canisters will be used as field blanks. These field blanks shall accompany the field deployment crew but shall remain sealed in their

plastic bags. During the radon collection period, store the field blanks in a low radon background area such as a drafty building. Protect the plastic bags from direct exposure to sun, harsh chemicals, or intense heat.

- 3.3.4 Review the forms to ensure that the data entry for each canister is complete. If location coordinates are not provided, carefully construct a map using natural bench marks as reference points and provide each location with a unique identifier. Alternatively, GPS/GIS capabilities may be used to identify locations.

3.4 Retrieval

- 3.4.1 Prior to retrieving canisters review Data Acceptance Criteria in section 3.5 below. As canisters are retrieved, record the retrieval time and date. Also record under “comments” those canisters that do not meet the acceptance criteria.
- 3.4.2 Remove the canisters after a minimum of 24 hours and maximum of 28 hours. Remove all soil and tailings from each canister by wiping the canister with a clean cloth or paper towel. Place the canister in a plastic bag, removing as much air as practical and carefully seal.
- 3.4.3 Place all canisters (including field blanks) in the specially designed shipping cartons. Tape the cartons and ship overnight delivery to the ERG laboratory.

3.5 Data Acceptance Criteria (from EPA Method 115)

- 3.5.1 At least 85 percent of the measurements must yield useable results. Otherwise, all measurements must be repeated.
- 3.5.2 Deployment may not be initiated if there has been rainfall within the past 24 hours.
- 3.5.3 If a rainfall occurs during the 24-hour measurement period, the measurement is invalid if the seal around the lip of the canister has washed away or if the canister is surrounded by water.
- 3.5.4 Measurements shall not be performed if the ambient temperature is below 35 degrees Fahrenheit or if the ground is frozen.
- 3.5.5 The canisters must be allowed to collect for approximately 24 hours.

4. TRAINING

- 4.1 Prior to use in the field, all personnel must show proficiency in the use of ERG radon flux canisters.
- 4.2 Prior to use in the field, all personnel must show understanding of this SOP and EPA Method 115.
- 4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

- 5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3).
- 5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

- 6.1 Project personnel using this procedure should become familiar with the contents of the following documents:
 - ERG SOP 4.3
 - Form 4.00
 - EPA Method 115

7. ATTACHMENTS

- 7.1 Form 2.07 – Radon-222 Canister Deployment Record

Author's Signature:	Reviewed By:
<i>Charles P. Farr</i>	<i>Kenneth R. Baker</i>

STANDARD OPERATING PROCEDURE 2.31
GAMMA-RADIATION CORRELATION STUDIES
OVER AREAS

1. PURPOSE

This Standard Operating Procedure (SOP) outlines a method for developing a correlation between Global Positioning System (GPS)-based gamma-radiation (gamma) surveys and radium-226 concentrations in surface soil (0 to 15 centimeters [cm]).

2. DISCUSSION

This is a method to develop correlations between the gamma count rate measurements obtained in GPS-based gamma surveys and radium-226 concentrations in soil.

A GPS-based gamma survey first is performed. Areas representing select ranges of observed count rates are chosen from the data set and their dimensions defined *a priori*. GPS-based measurements are made therein, using the same methods as those adopted for the wider survey, with tighter transect spacing. Composite surface soil (0-15 cm) samples then are collected and analyzed for radium-226 concentrations. A scatter plot of the gamma count rate measurements and radium-226 concentrations then is created and a linear regression performed to develop an equation correlating gamma count rates to predicted radium-226 concentrations.

3. PROCEDURE

3.1 Equipment

- 3.1.1 Ratemeter/Scaler and detector.
- 3.1.2 GPS.
- 3.1.3 Collimator (if specified).
- 3.1.4 Field notebook and/or appropriate forms.
- 3.1.5 Indelible ink pen.
- 3.1.6 Hand auger, or equivalent.

3.2 Data Collection

3.2.1 Area Studies

- 3.2.1.1 Choose horizontal dimensions of study areas; e.g., 100 square meters.

Choose study areas representing select ranges of count rates. Ten or more areas are usually sufficient. The areas should be relatively flat and gamma count rates

therein should be relatively homogeneous and not affected by gamma shines.

3.2.1.2 Perform a GPS-based survey of each areas, at pre-selected transect spacing, using the same speed and detector height as used in the wider survey. Refer to SOPs pertinent to the equipment being using for more information.

3.2.1.3 Collect 5-point composite surface soil sample at locations shown in Figure 2.31-A, using a hand auger.

3.2.1.4 Send entire sample to laboratory for them to homogenize and subsample for analysis.

3.2.1.5 Repeat steps 3.2.1.1 through 3.2.1.4 at each area.

3.3 Linear Regression

3.3.1 In Microsoft Excel or other appropriate program, enter the central tendency of the gamma count rates and associated radium-226 concentration for each area.

3.3.2 Plot the data in an XY scatter plot.

3.3.3 Add a trend line and equation to the plot. This equation is the linear regression and can be used to predict radium-226 concentrations over the range of gamma counts found observed the wider survey.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation of the gamma-radiation survey equipment.

4.2 Prior to use in the field, all personnel must show proficiency in the use of Microsoft Excel or other equivalent program to create scatter plots and trend lines.

4.3 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1-4.2 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer-generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES



6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 Form 2.09A

Author's Signature:	Reviewed By:
	

STANDARD OPERATING PROCEDURE 4.01
TRAINING, INDOCTRINATION, AND CERTIFYING PERSONNEL

1. PURPOSE

To describe the procedures for training, indoctrination, and certification of personnel.

2. DISCUSSION

This procedure supports the ERG QA Plan.

3. PROCEDURE

3.1 Position Requirements and Selection.

3.1.1 Management shall define the minimum educational, experience, and other qualification requirements for positions involved in the performance of project quality-affecting activities

3.2 Orientation and Training

3.2.1 Management shall assure that all personnel performing activities affecting quality are trained and indoctrinated as to the purpose, scope, and proper implementation of the QA plan. The specific QA requirements and task procedures to assure proficiency shall be emphasized. Documentation of training shall be done and placed in the project file.

3.2.2 Management shall assure that general and project-specific environment, safety, and health (ES&H) training shall be given to all personnel. Documentation of training shall be done and placed in the project file

3.2.3 The QA Manager is responsible for assuring that this orientation and training occurs prior to quality-affecting work begins.

3.3 Personal Certification

3.3.1 Personnel responsible for performance, inspection, and control of certain special processes and operations that require special skills and have an effect upon quality shall be certified. Confirmation of adequate training shall be documented through written exams, oral exams, task performance demonstrations, or other means. A record of the names of certified personnel, their skills, and certification periods shall be maintained in the project files.

3.4 Proficiency Evaluation

3.4.1 Immediate supervisors shall continuously monitor (maintain awareness of) personnel proficiency in understanding their job requirements, competently performing their assigned quality-affecting tasks, and progressively improving their capabilities. Formal evaluation of proficiency should be documented as part of the usual performance appraisal process. If an individual's level of proficiency is unsatisfactory, project supervisors should, in addition to standard personnel actions, suspend the applicable job task, counsel the individual, and assign appropriate training or professional development.

4. TRAINING

4.1 Not applicable.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.3)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.



6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.3

7. ATTACHMENTS

None.

Author's Signature:	Reviewed By:
	

STANDARD OPERATING PROCEDURE 5.14
PERFORMING GPS RADIOLOGICAL SURVEYS BY “BABY JOGGER” PUSH CART

1. PURPOSE

To describe the method for the radiological surveying with a baby jogger pushcart (pushcart).

2. DISCUSSION

Oftentimes the scale of radiological surveys needed make their completion on foot difficult. Where site conditions allow it, completion of such surveys by vehicle are a possible alternative. The decision to utilize pushcart based surveys (as opposed to other survey methods) will typically be made by the project management team prior to deployment in the field..

3. PROCEDURE

3.1 Equipment

3.1.1 Typical GPS Radiological Survey Setup (see SOP 5.11)

3.1.1.1 It is possible to operate multiple GPS setups on a single pushcart. In this case, the equipment should be complete for each individual setup.

3.1.2 Extended C-C cable (to replace curly-C cable)

3.1.3 Extended antenna cable (to replace standard antenna cable)

3.1.4 Pushcart equipped with detector bracket(s)

3.2 Setup

3.2.1 Place the GPS units, camcorder batteries and Ludlum 2221 meters in the foam seat in the middle of the baby jogger.

3.2.2 Mount the detector probes onto the detector bracket attached to the push cart.

3.2.3 Mount the GPS antennas to the crossbar directly above the detector probes. Keep note that the antennas should be high enough the line-of-sight to the satellites will not be blocked.

3.2.4 Mount the Trimble TSCe data loggers to the crossbar.

3.2.5 Attach each Trimble TSCe to its corresponding GPS unit and Ludlum 2221 RS232 serial port.

3.2.6 Attach each detector to its corresponding 2221 using a C-C cable.

3.2.7 Attach the battery clips from each GPS unit to the camcorder batteries.

3.2.8 Perform the necessary daily function checks as directed by field supervisor.

3.3 Operation

3.3.1 It is important to achieve proper survey coverage. Proper coverage means there are no large voids in data without an explanation such as standing water or excessive vegetation. Excess readings are acceptable, but too dense of data will result in poor visual display.

3.3.2 Move the push cart to the area to be surveyed and turn on all survey equipment

3.3.3 It is often helpful to have a background file placed on the TSCe to ensure the proper area is surveyed. If a background file is loaded onto the TSCe, it will show up as a polygon on the map view and may appear in a different color as the survey path.

3.3.4 Begin surveying the area with the survey speed that is specified by a work plan or the project manager (typically 1 to 2 feet per second) and cover the entire survey area as outlined by the background file if one exists.

4. TRAINING

4.1 Prior to use in the field, all personnel must show proficiency in the operation the GPS radiological survey attached to the pushcart.

4.2 Prior to personnel being assigned to the field, supervisor must sign off of the Training Qualifications Form that he/she met requirements 4.1 above.

5. RECORDS

5.1 Records of the completed work, measurements, calculations, and data must be preserved, protected, and retained according to the contract and/or ERG's record retention process (see SOP 4.03)

5.2 Computer generated files will be saved as print and electronic files and stored with field notebooks.

6. REFERENCES

6.1 Project personnel using this procedure should become familiar with the contents of the following documents:

SOP 4.03

Form 4.00 Training Qualification Form

7. ATTACHMENTS

7.1 None.

Author's Signature:	Reviewed By:
<i>Charles P. Farr</i>	<i>Kenneth R. Baker</i>

SOP-NW-7.2

COLLECTION OF SOIL SAMPLES

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1.0 SUMMARY AND SCOPE

The purpose of this document is to define the standard operating procedures (SOP) for the collection and handling of soil samples using hand operated devices. This SOP does not describe sampling procedures for lithified deposits or rocks or sampling procedures using drill rigs. This SOP applies to any work performed by MWH or subcontractor personnel for any portion of soil sampling and is intended to be used in conjunction with site-specific workplans or sampling and analysis plans (SAPs). Modifications to this SOP may be made with the approved by the Project Manager or Task Leader and the Quality Assurance (QA) Manager.

2.0 DEFINITIONS

None.

3.0 HEALTH AND SAFETY WARNINGS

Safety glasses should be worn at all times when taking soil samples to protect from dust particles. Care should be taken to minimize the disruption of the soil to minimize dust. A deionized water spray bottle may be used to dampen the earth and minimize dust if necessary.

4.0 PERSONNEL RESPONSIBILITIES

4.1 Field Sampling Engineer

The Field Sampling Engineer (or field team member) is responsible for sample collection, sample custody in the field, sample preservation, field testing, total and accurate completion of data sheets, sample shipment and delivery of data to the Project Manager and designated project secretary, all as described in this technical procedure. All staff are responsible for reporting deviations or nonconformance of the procedure to the Field Team Leader, Project Manager, or Quality Assurance (QA) Manager, in compliance with the governing workplan or SAP requirements

4.2 Field Team Leader

The Field Team Leader is responsible for supervising the Field Sampling Engineers. Supervision includes ensuring that samples are collected, documented, preserved, field analyzed, handled and shipped to the appropriate laboratory as specified in project work documents and this technical procedure.

4.3 Project Manager

The Project Manager has overall management responsibilities for the project, is responsible for designing the sampling program, for arranging the logistics of the program, and for providing any required clarifications in the use of this procedure. The Project Manager may assume the responsibilities of the Field Team Leader on smaller projects.

The Project Manager is also responsible for maintaining project files and filing project documents, project correspondence, chain of custody forms, soil sampling forms, generated data, and other associated and pertinent project information.

4.4 QA Manager

The QA Manager is responsible for developing and managing procedures outlined in the SOPs and in site specific SAPs, QA plans, and/or workplans.

5.0 DISCUSSION

The methods described by this procedure may be used to acquire soil samples for chemical or radiological analysis. Methods should be selected at the discretion of the Field Team Leader or Project Manager in accordance with any specific provisions of governing SAPs, QA plans, and/or workplans.

6.0 PROCEDURE

The sampling method described in this SOP is suitable for collecting soil samples. Because of the potentially high degree of heterogeneity found in soils, the collection of representative samples requires careful planning and considerable technical judgment. Sampling locations shall be as specified in the governing workplan or SAP. However, the preferred sampling strategy requires collection of subsamples from the specified sample location and compositing of those subsamples in the field to form a single sample before shipment.

6.1 Equipment List

The following is a list of required equipment for performing soil sampling:

- Copy of this SOP and applicable workplan or SAP
- Balance with a 250-gram capacity calibrated to ± 0.1 grams (optional)
- Bound field notebook
- Sterilized latex or nitrile gloves
- Decontamination equipment and waste containers
- Detergent solution (0.1 to 0.3 percent Alconox or equivalent detergent)
- Distilled water
- Hand-operated soil collection device
- 100-ft measuring tape
- Sample bags
- Sample containers
- Sample labels and seals
- U.S. Standard Sieve No. 10 with collection pan and cover (optional)
- Site map of sampling area
- Soil sample collection form (see attachment)
- Soil coring device
- Stainless steel mixing bowl
- Stainless steel spoon or hand shovel

Criteria for selecting appropriate soil samples will follow ASTM Standard D 4700-91, Standard Guide for Soil Sampling from the Vadose Zone (ASTM, 1998).

6.2 General Considerations

The selection of sampling locations shall be as specified in the applicable workplan or SAP. The sampling site shall be photographed if so specified in the governing workplan or SAP. Samples will be composited in a manner specific to each sample location; compositing is described in Section 6.2.1. In addition, to remove residual organic matter and large soil particles, each soil sample designated for trace metals analysis may be sieved prior to shipment, if required by the governing workplan or SAP. The sieve procedure is described in Section 6.2.2. During soil sampling operations, the proper personal protective equipment will be worn, as described in the applicable workplan or site safety and health plan.

6.3 Soil Sampling

The procedures for collecting one soil sample at a given location is as follows:

- Using decontaminated sampling equipment under the protocols described in Section 6.5, collect soil from the interval of concern or to refusal of the equipment.
- If the equipment is refused, record the depth of refusal.
- Retain the soil in a decontaminated, stainless steel mixing bowl.

If two or more samples are to be collected from differing depths at a single sample location, the procedure for collecting soil is as follows:

- If the upper layer of topsoil is to be collected, begin by driving a clean stainless steel sample coring device two inches into the ground with a hammer until the top of the box is flush with the ground.
- Remove the material within the coring bit to the required depth with a decontaminated stainless steel scoop or spade.
- Retain the sample in a clean, stainless steel mixing bowl.
- If an additional sample is required at a depth below the topsoil sample, remove at least one-inch of soil and discard.
- If no topsoil sample is collected, remove soil to the top of the desired sample interval from an area having a minimum diameter of eight inches to avoid cross-contaminating soil layers using a decontaminated stainless steel tile spade.
- Using decontaminated sampling equipment under the protocols described in Section 5.5, collect soil from the interval of concern or to refusal of the equipment.

- Retain the soil in a clean stainless steel mixing bowl.
- If additional samples are required at deeper intervals, repeat procedure until refusal.

6.3.1 Compositing

If soil samples are collected at a particular location, the following procedure will be used for compositing:

- Combine each sample in a decontaminated stainless steel mixing bowl.
- Mix the contents of the mixing bowl for several minutes.
- Remove material other than soil, such as litter, root matter, and rocks. Shake soil material from roots and sod.
- Mix again for several minutes to obtain a homogeneous mixture.
- Fill designated sample containers with the homogenized soil mixture as discussed in Section 6.5.
- Retain or dispose of the remaining soil mixture as specified in the applicable workplan or SAP.

Homogenization of samples may also occur at the analytical laboratory, per the governing workplan or SAP. Thus, field homogenization would not be necessary.

6.3.2 Sieving

Soil collected for the analysis of trace metals shall be sieved to remove residual organic detrius and larger soil particles if required by the governing SAP or workplan. Sieving will follow the following procedure:

- Place soil in top of a sieve having a maximum opening size of 2.0 mm and equipped with a collection pan, cover and manually agitate.
- At the end of sieve procedure, weigh soil particles that are retained on the sieve and the collection pan.
- Discard soil particles retained on the sieve.

Sieving of samples may also occur at the analytical laboratory, per the governing workplan or SAP. Thus, field sieving would not be necessary.

6.4 Sample Acquisition Methods

6.4.1 Thief Sampler

The “thief” sampler consists of two slotted concentric stainless steel tubes with a pointed tip. The inner tube may be rotated to isolate the sampler interior. It is recommended for use in the sampling of dry granular or powdery soils with a particle diameter less than one third the width of its slots. To take a sample, close the sampler and insert it into the soil to the desired sampling interval.

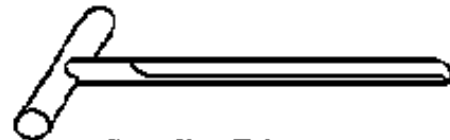


Thief Sampler

Rotate the inner tube to open the sampler, and tap gently to induce a flow of soil into the interior. Close the sampler, withdraw it from the soil, and lay it horizontally, with the slots facing up. Remove the inner tube and transfer the sample to an appropriate sample container or decontaminated compositing bowl.

6.4.2 Sampling Trier

The sampling trier is recommended for use in cohesive soils with a particle size less than half the trier diameter. To acquire a sample, insert the trier into the sampling interval at a 45 degree angle, and rotate the handle 360 degrees to cut soil core. Withdraw the trier with the concave side up, and transfer the sample material to an appropriate sample container or decontaminated compositing bowl.



Sampling Trier

6.4.3 Slide Hammer Core Sampler

The slide hammer core sampler is recommended for use in rockier soils and soils with a hard, compact surface.

To prepare the sampler for coring, take the following steps:

- Insert a suitable liner into the body (cup);
- Thread the top cap to the upper end of the cup and tighten;
- Attach the extension to the top of the sampler and tighten;

- Attach the slide hammer to the extension and tighten.

To collect a core sample, raise the slide hammer body and allow it to fall to drive the sampler into the soil. Continue until the sampler has been driven to its length. Remove the sampler by tilting and lifting horizontally. Disconnect the sampler from the extension and slide hammer using wrenches if necessary. Keeping the sampler vertical, remove the top cap carefully, using a slip wrench if necessary. Remove the filled liner by first extruding it from the body by pushing up from the sampler lower end. Empty the sample into the appropriate container or compositing bowl. Use a decontaminated liner for each sample.

6.4.4 Portable Auger

Hand- or electric motor-operated portable augers should generally be used in hard-packed soils or sediments. Because of the potential for site contamination, gasoline-powered augers are not permitted unless specifically authorized by approved project-specific plans. To acquire a sample, insert the auger through the catchpan at the desired sampling location and rotate the auger to the required sampling interval. Withdraw the auger and transfer the sample material in the catchpan (or that may have adhered to the auger surface) to an appropriate sample container or decontaminated compositing bowl using a decontaminated stainless steel spoon, trowel, or spatula.

6.4.5 Grab Samples

When permitted by site-specific project plans, grab samples may be taken with a decontaminated shovel or trowel and directly transferred to an appropriate sample container or decontaminated compositing bowl.

6.5 Sample Handling

Sample handling procedures and chain of custody requirements shall be as specified in the governing workplan or SAP. Typical handling procedures for soil samples are as follows:

- If specified in the site workplan or SAP, a photograph should be taken of the soil sample.
- Using a decontaminated stainless steel scoop, empty each soil sample in the mixing bowl to composite.
- Fill the container with a portion of the composited sample. Attempt to maintain the proportion of solids that exist in the mixing bowl while filling containers.
- Store sample containers in coolers for transportation in compliance with the sample handling and chain-of-custody requirements specified in the workplan or SAP.
- Sample documentation and labeling requirements shall be as specified in the governing workplan or SAP.

During soil sampling operations, the proper personal protective equipment will be worn, as described in the applicable workplan or site safety and health plan to minimize cross-contamination.

6.6 Decontamination

Sample acquisition and compositing tools shall be decontaminated as follows:

1. Ensure that the cleaning solutions and rinseate containers required by governing sampling plans are available.
2. Scrub the sample acquisition or compositing tool with a brush and rinse with deionized or distilled water.
3. Dispose of the rinseate and wiping rags in the manner specified in governing sampling plans.
4. Wrap the decontaminated device in clean plastic sheeting or bags and tape securely pending next use.

7.0 RECORDS MANAGEMENT

The attached Soil Sample Collection Form is to be completely filled out for each corresponding soil sample. This form should be reproduced in a field book along with any notes or unexpected events that may accompany the effort.

8.0 QUALITY ASSURANCE AND QUALITY CONTROL

The approved quality assurance and quality control measures will be applied as described in the applicable workplan or quality assurance plan.

9.0 REFERENCES

ASTM D4700-91 (1998)e1. "Standard Guide for Soil Sampling from the Vadose Zone". ASTM International. Available: www.astm.org

SOIL SAMPLE COLLECTION FORM

Project: _____

Project Number: _____

Date: ____ / ____ / ____

Time: _____

Field Personnel: _____

Signatures: _____

SITE DESCRIPTION

Site Location: _____

Station Number: _____

Photo. No.: _____

Roll No.: _____

GPS Coordinates: Latitude _____ ° ' " Longitude _____ ° ' "

—

Elevation _____

Comments/Descriptions: _____

FIELD DESCRIPTION

Sample Identification Number: _____

Soil Characteristics (color, appearance, structure): _____

Collection Method: _____

Sieve Analysis: Size _____

Weight Retained _____

Comments/Descriptions: _____

APPENDIX B

RADIOLOGICAL SITE AND BACKGROUND INVESTIGATION SAP

QUALITY ASSURANCE PROJECT PLAN

APPENDIX B

RADIOLOGICAL SITE AND BACKGROUND INVESTIGATIONS

QUALITY ASSURANCE PROJECT PLAN

REVISION 2

FINAL

JULY 2014

PREPARED BY:
MWH AMERICAS, INC.

PREPARED FOR:
P4 PRODUCTION, LLC

QUALITY ASSURANCE PROJECT PLAN APPROVAL SHEET

Approved by:

Program Manager
MWH

Date

Quality Manager
MWH

Date

Program Manager
P4 Production

Date

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ACRONYMS AND ABBREVIATIONS

901.1M	901.1 Modified
ASTM	American Society for Testing and Materials
COPC	chemicals of potential concern
CVAA	Cold Vapor Atomic Absorption
DER	Duplicate error ratio
DQI	Data Quality Indicator
DQO	Data Quality Objectives
dw	Dry Weight
EDD	Electronic Data Deliverable
EPA	United States Environmental Protection Agency
ER	Equipment Rinsate Blank Sample
FCR	Field Change Request
FSP	Field Sampling Plan
GPS	Global Positioning System
HSP	Health and Safety Plan
ICPMS	Inductively Coupled Plasma/Mass Spectroscopy
ID	Identification
IDEQ	Idaho Department of Environmental Quality
K-40	potassium-40
LCS	Laboratory Control Sample
LLCCS	Low-Level Calibration Check Standard
MDL	Method Detection Limit
mg/kg	Milligrams per Kilogram
mg/L	Milligrams per Liter
mL	Milliliters
MS	Matrix Spike
MSD	Matrix Spike Duplicate
na	Not Applicable
NELAP	National Environmental Laboratory Accreditation Program
NOAEL	No Observed Adverse Effect Level
ORNL	Oak Ridge National Laboratory
P4	P4 Production, LLC
pCi/g	picocuries per gram
pCi/L	picocuries per liter
QA	Quality Assurance
QAPP	Quality Assurance Project Plan
QC	Quality Control
Ra-226	Radium-226
RL	Reporting Limit
RPD	Relative Percent Difference
RSD	Relative Standard Deviation
SAP	Sampling and Analysis Plan
SOP	Standard Operating Procedure
TPU	Total propagated error
USEPA	United States Environmental Protection Agency

1.0 PROGRAM MANAGEMENT

1.1 INTRODUCTION

This quality assurance project plan (QAPP) is Appendix B of P4 Production's (P4) *Radiological and Background Investigations Sampling and Analysis Plan (SAP)* for three Monsanto mine sites; Ballard, Henry, and Enoch Valley mines, as part of the P4 Sites Remedial Investigation/Feasibility Study (RI/FS). The SAP is comprised of a Field Sampling Plan (FSP-Appendix A), this QAPP (Appendix B), and a Health and Safety Plan update for this project (HSP-Appendix C). This QAPP has been prepared consistent with United States Environmental Protection Agency (USEPA) guidelines (USEPA, 2002). The QAPP describes the measures that will be employed during the radiological and background investigation to assure that data generated are of known and defensible quality in relation to the overall objectives of the investigation. The various plans and procedures cited in this document govern the project sample acquisition efforts, sample handling and chain-of-custody protocols, laboratory analyses, data handling and data management, field documentation, quality auditing of field operations, corrective/preventive action processes, and management of project quality records.

1.2 PROJECT ORGANIZATION

The project team for the radiological and background investigation is specified in Section 5.0 of the FSP (Appendix B of the SAP). P4 has contracted the following in support of this investigation:

- ALS Environmental (ALS), Fort Collins, Colorado, is the contract laboratory for metals and radiological analyses.
- Laboratory Data Consultants, Inc., Carlsbad, California, is the contract 3rd-party data validator.

1.3 PROGRAM DESCRIPTION

The overall scope and purpose of the radiological and background investigation is discussed in the SAP. At the discretion of the MWH Program Manager and the P4 Program Manager, any required scope modifications or additions may be accommodated either by revisions to the SAP documents or through the use of the field change request (FCR) process described in Section 1.6.6.

1.4 QUALITY OBJECTIVES AND CRITERIA FOR MEASUREMENT DATA

1.4.1 Purpose of QAPP

The QAPP describes the measures that will be employed during the radiological and background investigation to assure that data generated are of known and defensible quality in relation to the overall objectives of the investigation. The primary objective of this QAPP is to assure that the precision and accuracy of project data are known and documented, that sample collection, analysis, and reporting are complete, and that samples are representative of tested environmental media. This plan also provides guidance for documentation of information collected in the field, sample custody, and the collection of appropriate field QC samples.

1.4.2 Data Quality Objectives

The DQOs for this sampling program are described in the SAP (Table 2-1). These DQOs are consistent with USEPA guidelines (USEPA, 2006), which describe the systematic planning of data collection activities to assure that the proper type, quality, and quantity of data are collected. The DQOs will be fulfilled by following specific procedures and requirements outlined in the FSP and this QAPP for sample collection and handling; field and laboratory QC sample analysis; laboratory-specific preventative maintenance measures; data review and reduction by the designated laboratories; data verification, validation, and reporting; and quality auditing and corrective/preventive action processes.

The field sampling and analysis design is provided as Step 7 of the DQO process in the SAP, and detailed in Section 3.0 of the FSP. Based on the rationale presented in the SAP and FSP, the following soil samples will be collected during this field effort.

Background Investigation - In each of the Background Areas, the geologic units to be sampled for soil COPCs will include - (1) the Meade Peak, and (2) the Rex Chert/Cherty Shale Members of the Phosphoria Formation, and (3) the Wells Formation. Background data for soil COPCs is available for the Wells and Dinwoody Formations from the 2009 Soil and Vegetation program. Twenty samples were collected from the Dinwoody Formation in 2009 and 10 samples were collected from the Wells Formation during the 2009 investigation. In order to have a similar number of samples from each of the geologic units, 10 additional samples will be collected from the Wells Formation (5 from each Background Area). In addition, P4 will collect ten (10) additional samples for the

Dinwoody Formation. These samples will be used for qualitative comparison to the previous Dinwoody Formation samples collected the Henry and Enoch Valley Mines. However, they will be excluded from the background data set in favor of the Henry and Enoch Valley samples collected in 2009.

- Ten (10) composite soil samples from the Meade Peak Formation in each Background Area for a total of 20 samples.
- Ten (10) composite soil samples from the Rex Chert Formation in each Background Area for a total of 20 samples.
- Five (5) composite soil samples from the Wells Formation in each Background Area for a total of 10 samples.
- Five (5) composite samples from the Dinwoody Formation in each Background Area for a total of 10 samples. These samples will be used

Each of the 50 composite background investigation soil samples will be analyzed for the following target analytes using the analytical instrumentation specified as follows:

- Antimony, arsenic, boron, cadmium, chromium, cobalt, copper, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc (chemicals of potential concern [COPC] metals) by ICPMS (USEPA Method 6020A).
- Mercury by cold vapor atomic absorption (CVAA; USEPA Method 7471A).
- Ra-226, K-40, and Th-232 in soil by gamma spectroscopy via USEPA Method 901.1M.

Radiological Correlation Study - Radiologic correlation studies will be necessary both On-Site and in the Background Areas. Composite sampling locations will be selected spanning the count-rate range across the selected units (i.e., On-Site and Background Areas; see footnote “a” on Table 1-1).

On-Site Soil Sampling:

The areas or units to be sampled will be based on the gamma-based GPS survey, but for the purposes of this discussion assume:

- Four (4) composite soil samples at Ballard Mine.
- Three (3) composite soil samples at Henry Mine.
- Three (3) composite soil samples at Enoch Valley Mine.

Background Area Soil Sampling:

- Five (5) composite soil samples across the four geologic units located in Caldwell Canyon.
- Five (5) composite soil samples across the four geologic units located in Blackfoot.

Each of the 20 soil samples collected for the correlation study both on-site and in the background areas will be analyzed for the following target analytes using the analytical instrumentation specified as follows:

- Uranium in soil (and water QC samples) by inductively coupled plasma/mass spectrometry (ICPMS; USEPA Method 6020A).
- Radium-226 (Ra-226), potassium-40 (K-40), and thorium-232 (Th-232) in soil by gamma spectroscopy via USEPA Method 901.1 Modified (901.1M)

Radon Flux Study – Radon flux measurements will be necessary both On-Site and in the Background Areas as follows.

On-Site Measurements:

The three areas or units to be sampled will be based on the gamma-based GPS survey, but for the purposes of this discussion assume:

- 15 radon flux measurements at Ballard Mine.
- 15 radon flux measurements at Henry Mine.
- 15 radon flux measurements at Enoch Valley Mine.

Background Area Soil Sampling:

- 60 radon flux measurements across the four geologic units (15 measurements per unit) located in Caldwell Canyon.
- 60 radon flux measurements across the four geologic units (15 measurements per unit) located in Blackfoot Bridge.

Each of the 165 radon flux measurements will be collected using charcoal canisters and measured by ERG according to Method 115.

Sample identifications for all samples are listed on Table 1-1. Samples will be collected as described in Section 4.2 of the FSP (see also footnote “a” on Table 1-1). Field duplicates will be collected at a rate of 1 in 10 soil samples (a total of two composite soil sample field duplicates from the radiological correlation study and five composite soil sample field duplicates for the background COPC investigation) and a rate of 1 field duplicate measurement in each radon flux area (a total of 11 field duplicates).

Water field QC samples (equipment rinsate blank samples) will be analyzed for the following target analytes using the analytical instrumentation specified as follows:

- Antimony, arsenic, boron, cadmium, chromium (total), cobalt, copper, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc by ICPMS (USEPA Method 6020A).
- Mercury in by CVAA (USEPA Method 7470A)
- Ra-226 by radon emanation technique (USEPA Method 903.1)
- K-40 and Th-232 (water QC samples) by gamma spectroscopy (USEPA Method 901.1)

Project soil screening levels for each target analyte are provided on Table 1-2. The screening values are as follows:

- USEPA Human Health Soil Regional Screening Levels (RSLs)
- USEPA Ecological Soil Screening Levels

Although the soil data produced from the radiological correlation study and background investigation will not be screened against these values, the screening levels are presented to ensure that the laboratory reporting limits are sufficiently sensitive at the level of interest for these target parameters.

1.4.3 Data Quality Indicators

Data quality indicators (DQIs) may be expressed in terms of precision, accuracy, representativeness, comparability, completeness, and sensitivity. The DQIs are summarized in the following subsections, and the project performance measurement criteria are established on Table 1-3.

1.4.3.1 Precision

Precision is the mutual agreement among individual measurements of the same property and is a measure of uncertainty. There are two general forms of uncertainty. The first is lack of knowledge, and includes the random error component of the data collection process. Given the availability of appropriate resources and the absences of other constraints, such uncertainty can potentially be reduced or eliminated. The second form of uncertainty is inherent stochastic variability. For example, even if it were possible to sample and analyze for selenium with no error, different concentrations in different water bodies would be observed along with different concentrations over space and time in even one given water body. Variability is irreducible, that is to say, even with no time, resource, or other constraints, variability cannot be eliminated, and can only be described. The overall random error component of precision is a function of the sampling and analytical precision, and is assessed by the analysis of field replicates. The analytical precision is determined by the analysis of field replicate samples analyzed by the laboratory.

Precision can be measured as relative percent difference (RPD), or as relative standard deviation (RSD), which is also known as a coefficient of variation. Formulae are provided for calculation of RPD and RSD for metals analysis as follows:

$$RPD = \frac{\left| x_i - x_j \right|}{\left(\frac{x_i + x_j}{2} \right)} \times 100$$

Where: x_i and x_j are replicate or duplicate values of x

$$RSD = \frac{s}{\bar{x}} \times 100$$

Where: s is sample standard deviation and \bar{x} is the sample mean

The formula for the calculation of duplicate error ratio (DER) for radionuclide validation is as follows:

$$DER = \frac{\left| ([Sample] - [Duplicate]) \right|}{([TPU^2_{Sample}] + [TPU^2_{Duplicate}])^{1/2}}$$

Where: [Sample] = sample concentration

[Duplicate] = duplicate concentration

[TPU²_{Sample}] = the square of the total propagated error (TPU) of the sample

[TPU²_{Duplicate}] = the square of the TPU of the duplicate

1.4.3.2 Accuracy

Accuracy is defined as the degree of agreement between the true or expected value and the measured value for a given measurement. It is a measure of the bias or systematic error of the entire data collection process. Potential sources of systematic errors include:

- Sample collection methods
- Physical or chemical instability of the samples
- Interference effects
- Calibration of the measurement system
- Contamination

Accuracy can either be evaluated with a background level of an analyte or with the introduction of a known quantity of analyte. The evaluation of laboratory standard control samples will use the former method, as indicated in the first formula below. The evaluation of laboratory spiked samples will use the latter method, as indicated by the second formula below.

$$R = \frac{x}{t} \times 100$$

Where: x is the sample value and t is the true or assumed value

$$R = \frac{x_s - x}{t} \times 100$$

Where: x_s is the value of the spike sample; x is the value of the unspiked sample; and t is the true or assumed value

1.4.3.3 Representativeness

Data representativeness is defined as the degree to which data accurately and precisely represents a characteristic of a population, parameter variations at a sampling point, or environmental conditions. Representativeness is a qualitative parameter that is most concerned with the proper design of the sampling program. Representativeness of samples will be achieved through the careful selection of sampling locations and methods. The sampling program has been designed so that the samples collected are representative of the medium being sampled and that a sufficient number of samples will be collected to meet the DQOs.

1.4.3.4 Completeness

Completeness refers to the amount of useable data produced during a project. The procedures established in this QAPP are designed to ensure, to the extent possible, that data will be valid and usable. To achieve this objective, every effort will be made to collect each required sample and to avoid sample loss.

$$C = \frac{n}{N} \times 100$$

Where: n is the number of valid samples results and N is the total number of results associated with all planned samples

1.4.3.5 Comparability

Data comparability is defined as the measure of the confidence with which one data set can be compared to another. Comparability is a qualitative parameter, but must be considered in the design of the sampling plan and selection of analytical methods, quality control protocols, and data reporting requirements.

1.4.3.6 Sensitivity

Sensitivity is the capability of a method or instrument to discriminate between measurement responses representing difference levels of a variable of interest.

1.4.4 Goals

This section identifies numerical goals for precision and accuracy for the various environmental media. The completeness goal for measurements is 90 percent for soil samples. Failure to meet these goals will be considered in the data validation process described in Section 2.7.3. If data are unusable, as defined by the validation procedure, the results will be rejected. Further evaluations will be made and resampling or other appropriate actions initiated.

The following tables summarize the calibration and QC procedures and DQI goals for this project:

- Table 1-4: ICPMS Metals by EPA Method 6020A
- Table 1-5: Mercury by EPA Method 7471A (soil)/7470A (water QC samples)
- Table 1-6: Ra-226, K-40, and Th-232 (soil) by EPA Method 901.1M
- Table 1-7: Ra-226 (water QC samples) by EPA Method 903.1

1.4.4.1 Precision

Precision will be determined on field data and laboratory analysis data by the analysis of field duplicates, laboratory replicate, matrix spike and matrix spike duplicate (MS and MSD) results and evaluation of the RPD. The RPD goals are specified for each analytical method on Tables 1-4 through 1-7.

Duplicate samples will be collected at 10 percent of sampling locations. Each parameter of the duplicate sample and its applicable project screening values will be tabulated and presented in the relevant P4 RI Report. An RPD between two values will be calculated if the parameter is detected at a value greater than the reporting limit in both the primary and duplicate samples. If one or both the detected values are less than the reporting limit, then the absolute difference between the values will be calculated. RPDs and absolute differences will not be calculated if the parameter is not detected in either the primary or duplicate sample.

The data users will take into account the field replicate variability when assessing trends and/or decisions made with respect to field sample results. Variability associated with duplicate results will be a reflection of obvious variability associated with the soil material being sampled, as well as any inherent variability in the sampling and analysis of the tested material. Therefore, the precision of duplicate samples will be used to document this variability but will not be used to assess data usability with respect to comparisons of sample results to screening values.

1.4.4.2 Accuracy

Sample accuracy will be determined by the collection and analysis of field blanks. One equipment rinsate blank will be collected each day of sample for the sampling media. Laboratory accuracy is determined by the analysis of calibration and method blanks, calibration verification samples, laboratory control samples, and matrix spike samples. The laboratory criteria are specified on Tables 1-4 through 1-7.

1.4.4.3 Representativeness

Representativeness is addressed by the description of the sampling techniques and the rationale used to select the sampling locations. Sampling methods are described in the standard operating procedures (SOPs) contained in the FSP. Representativeness is also evaluated using RPDs between duplicate field samples, as well as a review of the results of equipment rinsate samples. These results will be tabulated and discussed in the relevant P4 RI Report.

Laboratory representativeness will be evaluated by reviewing completed chain-of-custody records (or “chains”), sample receipt forms, and sample preparation documentation to ensure that samples are stored, processed, and reported properly.

1.4.4.4 Completeness

The completeness goal of this project will be 90 percent for soil samples. A data gap analysis will be presented in the relevant P4 RI Report.

1.4.4.5 Comparability

Comparability will be ensured by sampling and analyzing soil samples consistent with procedures outlined in the FSP SOPs and standard EPA procedures. Data generated from soil samples will be reported in milligrams per kilograms (mg/kg) dry weight (dw) for metals and picoCuries per gram (pCi/g) dw for Ra-226, K-40, and Th-232. Data generated from equipment rinsate samples will be reported in milligrams per liter (mg/L) for metals and picoCuries per liter (pCi/L) for Ra-226, K-40, and Th-232. Laboratory data will be verified by a third-party validator and validated by MWH (see Section 2.7.3). Final project deliverables will be subject to independent technical review prior to submittal.

1.4.4.6 Sensitivity

Analytical sensitivity is assessed from instrument method detection limits (MDLs) for metals analysis. For metals' analysis, sensitivity is verified on a daily basis through the analysis of low-level calibration check standards (LLCCS). An LLCCS is spiked at the reporting limit. The acceptance criteria are specified on Tables 1-4 through 1-7. For radiological analysis, sensitivity is assessed from the replicate analysis of the preparation blanks and samples. A sample-specific minimum detectable concentration (MDC) and two sigma TPU are generated from these replicate analyses for each individual preparation blank sample. Concentrations for Ra-226, K-40, and Th-232 cannot be reported at values less than the sample-specific MDC, as specified on Tables 1-6 and 1-7.

Additionally, the analytical methodology needs to be sufficiently sensitive to detect the target parameters at concentrations less than the screening levels established for this project. The method reporting limits (and MDLs) for metals and the MDCs for radionuclides are listed on Table 1-2 with the applicable screening levels. All reporting limits for metals and the MDCs for radionuclides are sufficiently sensitive to detected target parameters at concentration less than all screening levels. Additionally, as stated in Section 1.4.2, the soil data produced from the radiological correlation study and background investigation will not be screened against these values; the screening levels are presented only to ensure that the laboratory reporting limits are sufficiently sensitive at the level of interest for these target parameters.

1.5 TRAINING REQUIREMENTS

MWH field personnel will be trained in the requirements of the SAP in a project meeting prior to the initiation of field activity. All personnel will read the SAP documents prior to the start of field work, and will acknowledge completion of training at the time of the project meeting. Meeting notes and attendance sheets will be kept and forwarded to the project records. In addition, prior to conducting each day's sampling activities, the Field Team Leader, or designee will conduct a "tailgate" meeting with field staff to review field procedures and sampling requirements, in order to better ensure that samples are collected and handled according to FSP and QAPP requirements. Tailgate meeting discussion subjects and attendees will be documented in the Field Logbook.

The Field Team Leader will maintain a hard copy of the current approved version of the entire SAP for ready-reference in the field vehicle or field office. Additionally, each field team will have a hard copy of the SAP.

1.6 DOCUMENTATION AND RECORDS REQUIREMENTS

1.6.1 Field Logbooks

Sample collection activities will be documented in permanently bound, page-numbered, weather-resistant field logbooks assigned to the Field Team Leader, or, if multiple sampling teams are used, to a designee in charge of each team. Each notebook will be identified to the project, task, and to the individual assigned custody of the logbook. For all sampling to be performed, the appropriate SOP, appended to the FSP, will also be employed. If logbook custody is transferred to another individual, such transfer will be noted in the logbook and signed and dated by both parties. All entries will be made in indelible ink; errors will be corrected by one single line through the text being revised, and all such corrections will be initialed and dated.

With the exception of the information contained in the appropriate SOP, governing the media to be sampled, bound field logbooks will be used to record the following information, as appropriate for the type of sampling being performed:

- Date, time, subjects, and attendees of daily tailgate training sessions
- Sample date, time, types, numbers, and quantities
- Sample container preservation steps performed
- Sample locations, including global positioning system (GPS) coordinates
- Numbers of associated photographs, with appropriate cross-references to the affected camera
- Sampling equipment used
- Decontamination steps performed
- Acknowledgements that chain-of-custody forms and express shipment information were properly completed

In addition, other ancillary information will be recorded, including:

- Time of arrivals/departures of MWH personnel and/or other visitors to the sampling site(s)
- Weather conditions
- Presence of livestock or wild game
- Time and subject of any incoming or outgoing telephone/radio contacts
- Any unusual events

The logbooks will be kept up to date on a daily basis; backup copies of each day's entries will be made on a weekly basis and forwarded separately to the project quality records, in addition to copies of all outgoing chains-of-custody and sample shipping documents.

1.6.2 Field Forms

In addition to the field logbooks, field forms will be required to be filled out by the sampling team conducting the sampling. All efforts will be made to fill out the information at the sampling location. Field forms for the sampling of soil are used to supplement the field logbooks. The appropriate forms are located in the applicable SOP, appended to the FSP.

1.6.3 Chain-of-Custody Records

Documentation of sample custody must be maintained from the time the samples are collected through: receipt at the destination laboratory; sample homogenization, preparation, and analysis; data recording and reduction; data validation; and final release of laboratory analytical data. Initial information concerning sample collection will be recorded in the field logbook as described in Section 1.5.1. Information on the custody, transfer, handling, and shipping of samples will be recorded by field personnel on a project-specific chain-of-custody form for ALS (Figure 1-1). A chain-of-custody form will be completed for each set of samples collected daily and will contain the following information:

- Sampler's signature and affiliation
- Project name and identification number
- Date and time of collection
- Sample identification number and matrix
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Method of shipment
- Shipping papers/waybill identification number (e.g., Federal Express tracking number as identified on pre-printed packing labels)

A copy of each as-transmitted chain-of-custody form will be retained in the project records.

1.6.4 Analytical Laboratory Records

The contracted analytical laboratory will be responsible for preparing analytical laboratory reports that are reviewed and approved by the laboratory's QA manager prior to submittal to MWH.

ALS's report will contain the following:

- A hard-copy data package with Level 3 deliverables (see Section 1.6.4.1) and a scanned (e.g., ".pdf") report with Level 4 deliverables (see Section 1.6.4.2).
- Electronic data deliverable (see Section 1.6.4.3)

The hard-copy and scanned reports will be paginated and organized with a table of contents. The hard-copy deliverable will contain a cross reference that correlates the field identification as provided on the chain-of-custody document with the laboratory's sample identification. Results should be presented on a form equivalent to the United States Environmental Protection Agency's (USEPA or EPA) Contract Laboratory Program (CLP) "Form 1." Results from QC samples associated with each distinct analytical method are to be presented all together on QC summary sheets for ease of review. A Case Narrative will be provided for each analytical method. The Case Narrative will discuss any problem related to sample-receipt, corrective action taken by the laboratory, QC outliers or other problems, method deviations, and/or clarifications or anomalies observed by the laboratory.

Sample Results for Metals' Analysis (CLP "Form 1" or equivalent) – This form contains all required data for field samples. The Form 1 will provide the following information:

- Field sample identification
- Laboratory sample identification
- Sample result(s) and appropriate units, method detection limit, and reporting limit. Concentrations equal to or greater than the method detection limit (MDL) must be reported. Concentrations between the MDL and reporting limit will be flagged as estimated ("J" flagged). Parameters that are not detected or present at a concentrations less than the MDL are flagged as "U" and interpreted to be not detected at a value equal to or greater than the MDL. Do not report "not detected" (or "ND").
- Sample collection and receipt dates
- Sample preparation date/time
- Analysis date/time
- Dilution factor
- Preparation batch number or identification

- Analysis batch number or identification
- Sample matrix and instrument
- For soil sample, the samples will be dried and homogenized; the basis of reporting will be reported as “dry-weight”

Sample Results for Radiological Analysis (CLP “Form 1” or equivalent) – This form contains all required data for field samples. The Form 1 will provide the following information:

- Field sample identification
- Laboratory sample identification
- Sample result(s) and appropriate units, minimum detectable concentration (MDC), and two sigma TPU. Ra-226 not detected or present at a concentrations less than the MDC are reported as “BDL” (below detection level) and interpreted to be not detected at a value equal to or greater than the MDC.
- Sample collection and receipt dates
- Sample preparation date/time
- Analysis date/time
- Dilution factor
- Preparation batch number or identification
- Analysis batch number or identification
- Sample matrix and instrument
- Percent moisture determination
- For soil samples, the samples will be dried, ground, sieved, and homogenized; the basis of reporting will be reported as “dry-weight”

1.6.4.1 Summary or “Stage 2B” Data Deliverable Package for Metals’ Analysis

All summary forms need to be present, following the Form 1s, with clear association of the QC batch to each sample (on the CLP Form specified or equivalent):

- Summary of all field sample results (as described above)
- Results of diluted and undiluted samples
- Sample results and preparation blank (Form IA-IN and IB-IN)
- Initial calibration verification (ICV) and continuing calibration verification (CCV) (Form IIA-IN)
- Low-level calibration check standard (LLCSS) (Form IIB-IN)
- Initial calibration blanks (ICB), continuing calibration blank (CCB), and preparation blanks (Form III-IN)

- Inductively coupled plasma (ICP) interference check sample (Form IVA-IN) or inductively coupled plasma-mass spectrometer (ICPMS) interference check sample (Form IVB-IN)
- Matrix spike and matrix spike duplicate (MS/MSD) sample recovery and MS/MSD relative percent difference (RPD) (Form VA-IN)
- Post digestion spike sample recovery (Form VB-IN)
- Laboratory duplicate precision (Form VI-IN)
- Laboratory control sample (LCS) recovery (Form VII-IN)
- ICP and ICPMS serial dilution percent differences (Form VIII-IN)
- MDLs (Form IX-IN)
- ICP interelement correction factors (Forms XA-IN and XB-IN)
- ICP and ICPMS linear ranges (Form XI-IN)
- Preparation log (Form XII-IN)
- Analysis run Log (Form XIII-IN)
- ICPMS tunes (Form XIV-IN)
- ICPMS internal standards relative intensity summary (Form XV-IN)
- Sample log-in sheet (Form DC-1)
- Deliverables inventory sheet (Form DC-2)
- Case narrative
- Chain-of-custody

1.6.4.2 Full Raw Data or “Stage 4” Data Deliverable Package

The Full Raw Data Package includes all items specified for the Summary Data Package (Stage 2B), plus instrument raw data and/or documentation of the following:

- Calibration standards (including source, preparation date)
- Blanks (ICB, CCB, and preparation)
- ICV and CCV standards
- Interference check samples
- Serial dilution samples
- LLCCS
- LCS
- Diluted and undiluted Samples
- Dilution factors
- Sample volumes
- Laboratory duplicates

- Matrix spikes (source, concentration, volume)
- Post digestion spikes (source, concentration, volume)
- Method of standard addition results
- Instrument identification
- Analysis date and time
- Integration time (CVAA only)
- All inorganic methods: full raw data print outs from instruments
- Full run log for each analysis

ICPMS to include: internal standard recoveries, tune data (atomic mass unit and peak width), and molecular interference check data.

1.6.4.3 “Stage 4” Data Deliverable Package for Radiological Analysis

All other summary forms need to be present, following the Form 1s, with clear association of the QC batch to each sample:

- Summary of all field sample results (as described above)
- Sample results and preparation blank
- ICV and CCV
- Laboratory duplicate precision
- LCS recovery
- Preparation log
- Analysis run Log
- Sample log-in sheet
- Case narrative
- Chain-of-custody document
- Instrument identification
- Analysis date and time
- Full raw data print outs from instruments
- Full run log for each analysis

1.6.4.4 Electronic Data Deliverable

Laboratory electronic data deliverables (EDDs) will contain detailed sample and laboratory QC sample data, including associations with QC batch sample results. Specifications for the EDD are provided in Attachment A.

1.6.5 Documents and Records

Documents and records are defined as completed, legible documents which furnish objective evidence of the items or services, activities affecting quality or the completeness of data, and which are maintained for the specific project. These records will be organized and managed in MWH's Bellevue, Washington program office and will include, at a minimum, the following:

- Original and backup copies of all bound field logbooks
- Field copies and original (laboratory) copies of all chain-of-custody documents
- Personnel training records (except that any medical monitoring program will be maintained in MWH's personnel files)
- Incoming and outgoing project correspondence (letters, telephone conversation records, faxes, and hard copies of e-mail messages)
- Copies of all laboratory agreements and amendments thereto
- Purchasing records for project supplies
- As-received laboratory data packages (hard copy and EDDs)
- Validated laboratory data packages
- All approved field change request (FCR) forms
- Draft and final versions of all reports and any associated presentation materials
- Draft and final delivered versions of the SI reports and its supporting procedures

1.6.6 Field Change Request Forms

Due to the conditions associated with field sampling activities, unexpected situations may occur that will require deviations or modifications to the requirements of the SAP. Other changes may be required by P4 during the course of this project. In such situations, the Program Manager may authorize the Field Team Leader or designee to undertake SAP modifications, provided that the scope of such modifications is discussed with the program Quality Manager and the EPA Project Manager and approved beforehand by both the program Quality Manager and EPA Project Manager. For significant changes, the EPA Project Manager should consult with the A/T before providing approval. Any modification to the SAP, FSP, or QAPP will be documented on a FCR form as shown in Figure 1-2. Each FCR will be uniquely numbered and will identify the project and task, the affected sections of the SAP or its supporting procedures, the scope of the requested variation, and the justification for its acceptance. At the Program Manager's discretion, the FCR

may be forwarded to appropriate P4 representatives for review purposes prior to implementation. The field team leader will update field personnel of any changes.

2.0 MEASUREMENT/DATA ACQUISITION

2.1 SAMPLING PROCESS

2.1.1 Sampling Design

The number and type of samples that will be collected and general sampling locations are presented in the FSP. Samples to be collected are summarized on Table 1-1.

2.1.2 Sampling and Analytical Methods – General Considerations

The SOPs invoked for the field sampling activities were developed from standard American Society for Testing and Materials (ASTM) methods. Analytical procedures performed by ALS will conform to standard EPA methods.

2.2 SAMPLING ACTIVITIES

2.2.1 Sampling Activity Summary

Sampling activities are summarized in the FSP, and consist of soil sampling at Ballard, Henry, and Enoch Valley mine sites.

2.2.2 Sample Collection and Preparation Protocols

Sampling activities and field parameter measurements will be performed in accordance with the FSP; and the related soil sampling SOPs that are provided in the FSP.

Soil samples for metals will be collected in one 4-ounce, wide-mouth glass jar with Teflon[®]-lined lids. Soil samples for radionuclides will be collected in one 16-ounce, wide-mouth glass jar with Teflon[®]-lined lids. Sample containers, preservation techniques, sample volumes, and holding time requirements are summarized on Table 2-1. All containers will be submitted to ALS as discussed in Section 2.3.1.

2.2.3 Sampling Equipment Requirements

Sampling equipment is specified in the matrix-specific sampling SOPs. All sample collection containers will be constructed of appropriate materials to facilitate decontamination; soil samples will be collected in glass jars.

Field equipment will be decontaminated between each sample. An equipment rinsate sample will be collected each day of sample collection for each matrix per field team. Equipment rinsate blank samples will be collected in pre-preserved polyethylene containers as specified on Table 2-1.

2.2.4 Sample Routing Requirements

All samples will be routed to ALS, located in Fort Collins, Colorado.

2.2.5 Sample Preservation Requirements

Sample containers with the necessary preservative will be provided by the contract laboratory in accordance with Table 2–1. All sample containers (jars, bottles) will be bagged in plastic bags, placed on wet ice, and stored in coolers prior to shipping to the appropriate laboratory for analysis.

2.2.6 Decontamination Procedures

Equipment used for collecting samples will be decontaminated prior to all sample acquisition activities. Sampling equipment will be decontaminated as follows:

- Remove excess rock fragments, soil, sediment, and vegetation
- Wash equipment with Crystal White™ (or equivalent) biodegradable soap/deionized water solution
- Rinse with potable water
- Rinse three times with deionized water
- Allow equipment to air dry

All rinsate may be disposed of onsite. Field personnel will handle field equipment and containers carefully to minimize the potential for cross-contamination. Containers will be handled in a manner to prevent direct contact with internal surfaces. Sampling personnel will avoid wearing items or clothing that may interfere with dexterity or create a potential source for cross contamination.

2.2.7 In-Process Sampling Data Review and Change Control

Review of field collection data will be conducted on site by the Field Team Leader on at least a daily basis. Based on this review, the Field Team Leader may request re-sampling or re-analysis of a particular sample or group of samples if omissions or discrepancies are found. Any changes in sampling procedures that may be required in order to address unanticipated field situations will be processed as an FCR as noted in Section 1.6.6. Other discrepancies will be discussed with the program Quality Manager and corrective and preventive action initiated as appropriate.

2.3 SAMPLE CUSTODY REQUIREMENTS

2.3.1 Sample Labeling and Handling

Samples will be labeled with all necessary information on laboratory supplied labels using waterproof ink. Pre-printed labels will contain the following information:

- Site location
- Sample identification
- Method of preservation, if used
- Sample matrix

The date and time of sample collection and sampler's initials will be added to the label at time of collection.

Each sample will be assigned a unique identification number. This number will be coded according to sample location according to the format specified in Section 4.1 of the FSP.

Sample containers will be sealed in plastic bags with wire ties and immediately placed on ice in an insulated cooler to $\leq 6^{\circ}\text{C}$. Insulated coolers will be provided by the contract laboratories or purchased locally. All samples will be stored in the coolers and handled as specified in Section 2.3.2.

2.3.2 Chain of Custody

Field personnel responsible for the collection of samples will sign and retain a copy of the chain-of-custody form, document the method of shipment, and send the original with the samples. The original signed chain-of-custody form will be sealed in a watertight plastic envelope and attached to the inside lid of the cooler. Coolers will be secured with strapping tape and a container seal applied that is covered with clear strapping tape. After samples are packed and sealed, coolers will be transferred to P4 Productions LLC, Shipping and Receiving: 1853 Highway 34, Soda Springs, Idaho for express carrier pickup. If for any reason samples cannot be shipped on date of collection, the coolers will be transferred to Fox Hills Ranch for storage. Samples will be stored in a refrigerator fitted with a keyed lock; the key location will be made known only to the Field Team Leader or designees.

Samples will be shipped by overnight express carrier to ALS in time to meet all required holding times; the carrier waybill number will be recorded on the original chain-of-custody document. Copies of the chains and waybills will be forwarded to the project quality records by the Field Team

Leader. Immediately after the sample coolers are delivered to the carrier, the Field Team Leader or Analytical Task Manager will notify the analytical laboratory to expect sample deliveries. Samples will not be shipped on Friday without making prior arrangements with the destination laboratories.

Samples will be sent to ALS at the following address

ALS Environmental
225 Commerce Drive
Ft. Collins, CO 80524
(970) 490-1511
Attn: Amy Wolf

2.3.3 Holding Time Considerations

Immediately after collection, sample containers will be enclosed in plastic bags and placed in field coolers with wet ice. If there is no likelihood that a holding time will be violated, samples may be stored in the locked refrigerator at Fox Hills Ranch for one or more days. Constituent-specific holding times are presented in Table 2-1. Sample shipment will be scheduled to prevent the exceedance of any required holding period. Failure to conduct analyses within the required holding times may potentially require the qualification of associated analytical results and will prompt appropriate corrective and preventive action measures as discussed in Section 3.0.

2.3.4 Laboratory Operations

2.3.4.1 Laboratory Receipt and Logging

Coolers containing samples to be analyzed will be shipped via overnight express courier to ALS. When samples arrive at each laboratory, the designated laboratory custodian receiving the sample cooler will inspect the cooler custody seal. The custodian will sign the shipping chain-of-custody record and attach the carrier billing. The shipping chain and waybill will be archived in the laboratory project file; a copy of the shipping chain and waybill will be forwarded to MWH's Bellevue office for filing in the project quality records. The custodian will then open the cooler to inspect the samples for integrity and compare the number of containers and label information with the chain-of-custody form attached to the inside of the cooler lid. Cooler temperatures will be checked and documented on the chain-of-custody form. Broken custody seals, damaged sample containers, sample labeling discrepancies between container labels and the chain-of-custody form, and analytical request discrepancies will be noted on the chain-of-custody form. The Analytical Task Manager will be notified of any such problems; the Program Manager, or Field Team Leader, and the Quality Manager will be advised in turn if the issue constitutes a nonconformance. In any

case, discrepancies or nonconformance will be resolved and addressed prior to the samples being released to the laboratory for analysis.

Once any discrepancies are resolved, the laboratory custodian will enter the samples into an analytical custody log and will assign each sample a unique identification number that is cross referenced to the sample number assigned in the field. The identification number will be used by the laboratory in its internal tracking system and the status of any given sample can be checked at any time by referring to the laboratory numbers on the chain and in the laboratory log books. Both the laboratory and sample numbers will be cited when the analytical results are reported. The laboratory custodian will then sign the chain. The original chain-of-custody will be routed to the laboratory's data management group. Copies of chains documenting custody changes and documentation will be received and kept in the laboratory project files. The original chain-of-custody record will remain with the samples until final disposition of the samples by the laboratory. Samples, extracts, or digestates will not be sent to another laboratory without the written authorization of the Program Manager. If so authorized, such samples will be transmitted using a chain-of-custody form approved by the Program Manager. After sample disposal, a copy of the original chain-of-custody will be sent to the Program Manager by the analytical laboratory to be incorporated into the project quality records.

2.3.5 Sample Storage and Security

While in the laboratory, the samples and aliquots that require storage at $\leq 6^{\circ}\text{C}$, but above freezing, will be kept in a locked refrigerator prior to analysis. At a minimum, the following procedures will be applied:

- Samples and extracts will be stored in a secure area controlled by the laboratory's designated sample custodian
- Samples will be removed from the shipping container and stored in their original containers unless damaged; damaged samples will be disposed in an appropriate manner after notifying the MWH project chemist, and authorization to dispose is received and documented
- Whenever samples are removed from storage, removal will be documented
- Sample transfers will be documented on internal chain-of-custody records
- Samples and extracts will be stored after completion of analyses in accordance with contractual requirements, or until instructed otherwise by the MWH Analytical Task Manager
- Samples will not be stored with standards or sample extracts

2.3.6 Sample Tracking

Laboratory personnel will use chain-of-custody records or databases to generate backlist reports of any unanalyzed samples. The reports will include the collection times along with the project name and laboratory sample number, and will include the project name, field sample identifications, and sample matrix. Sample analyses will be scheduled on the basis of holding time considerations.

Analytical assignments will be reviewed on a daily basis to ensure that holding times are not exceeded. If holding times are exceeded during laboratory custody, the MWH project chemist will be immediately notified.

2.3.7 Sample Custody Records

Minimum requirements for laboratory sample chain-of-custody controls are as follows:

- Samples will be stored in a secured area
- Access to the laboratory will be through a monitored area; other outside access doors to the laboratory will be kept locked in accordance with local fire requirements
- A visitor's log will be maintained, and visitors will be escorted while in the laboratory
- Refrigerators, freezers, and other sample storage areas will be securely locked or maintained in a secured area
- Only authorized personnel will have keys to locked sample storage area(s)
- Samples will remain in secure sample storage until removed for preparation or analysis
- Sample transfers into and out of storage will be documented
- Custody records will be maintained by the laboratory's sample management group.

Samples, extracts, and digestates will be retained at the laboratory for at least 60 days after the laboratory's final analytical data report has been submitted to MWH, so that any potential analytical problems can be properly addressed. The samples, extracts, and digestates may then be discarded in an approved and environmentally safe manner unless otherwise directed by the Analytical Task Manager.

2.4 ANALYTICAL METHOD REQUIREMENTS

2.4.1 Sample Preparation

For each soil sample, ALS will air dry the sample. The laboratory will prepare soil samples consistent with SOP SOIL-1 (SOPs are provided in Attachment B). Subsamples will be obtained for matrix spikes prior to sample preparation and analysis.

2.4.2 Target Analytes and Methods

Table 1-2 provides a list of the target analytes. Target analytes will be analyzed using the following methods:

- Antimony, arsenic, boron, cadmium, chromium (total), cobalt, copper, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc by ICPMS using EPA Method 6020A
- Mercury by CVAA using EPA Methods 7471A (soil) and 7470A (water QC samples).
- Ra-226, K-40, and Th-232 in soil by gamma spectroscopy using EPA Method 901.1M
- Ra-226 (water QC samples) based on the emanation and scintillation counting of Ra-222 and progeny produced by the decay of Ra-226 using EPA Method 903.1
- K-40 and Th-232 (water QC samples) by gamma spectroscopy using EPA Method 901.1

2.5 QUALITY CONTROL REQUIREMENTS

2.5.1 Field Quality Control Samples

2.5.1.1 Equipment Blanks

Blanks are defined as sample material that is free of reportable concentrations of target analytes; the blanks are introduced at various stages of sample handling to monitor possible contamination introduced by various field activities. Only rinsate (or equipment) blanks will be used for this project. An equipment blank is a sample of the deionized water being used by the field team that is collected using decontaminated sampling equipment. Decontaminated sampling equipment in this event includes shears for vegetation and soil corers and mixing bowls for soil. One equipment rinsate blank sample will be collected at the end of each day of sampling per matrix per field team. Samples for equipment rinsate will be analyzed for all target analytes except Cr VI. Total chromium values will be used to evaluate impact of potential contamination for Cr VI.

2.5.1.2 Duplicate Sampling

A true field duplicate is a subsample that has been divided from the primary sample at some step in the sampling process. Field duplicate samples provide information on the precision of the sampling, transfer, and analytical process. At 10 percent of sampling locations, a field duplicate will be collected.

2.5.2 Laboratory Quality Control Samples

Laboratory quality control samples will be introduced into the measurement process to evaluate laboratory performance and sample measurement bias. Control samples may be prepared from

environmental samples or be generated from standard materials in the laboratory. Laboratory quality control samples used in each analytical method are discussed in the following sections. The requirements and acceptance criteria for the method-applicable QC samples are summarized for EPA Methods 6020A, 7470A/7471A, 901.1M, and 903.1 on Tables 1-4 through 1-7, respectively. Additionally, the laboratory will report, consistent with requirements listed in Section 1.6.4, the results of undiluted as well as diluted sample results and will consult with the MWH project chemist to justify and document the need for dilution.

2.5.2.1 Calibration Blanks

A calibration blank is used in establishing the analytical curve and monitoring for instrument contamination. The calibration blank is prepared by acidifying reagent water to the same concentrations of the acids found in the standards and samples. An initial calibration blank (ICB) is analyzed immediately following the initial calibration verification (ICV) standard, and a continuing calibration blank (CCB) is analyzed immediately following any continuing calibration verification (CCV) standard.

2.5.2.2 Method Blanks

Method blanks will be used for the laboratory processes. A method blank is a volume of deionized water or laboratory clean-matrix for solid samples (e.g., clean sand) that is carried through the entire sample preparation and analysis procedure. The method blank volume or weight will be approximately equal to the sample volumes or sample weights being processed. Method blanks are used to monitor interference caused by constituents in solvents and reagents and on glassware and other sampling equipment. A method blank is prepared and analyzed with each analytical batch of 20 or fewer samples.

2.5.2.3 Matrix Spikes

A spike is a sample to which is added a known amount of analyte(s) before analysis. From the concentrations of the analyte in the spiked and unspiked samples, a percent recovery is calculated. Many samples show matrix effects in which other sample components interfere with the determination of the analyte. The value of the percent recovery indicates the extent of the interference. A *matrix spike* is prepared by adding an analyte to a subsample of a field sample before sample preparation and analysis. An *analytical spike* is prepared by adding analyte to an aliquot of a processed sample prior to analysis, and is used to determine whether the analysis system provides

results that are representative of the sample when a matrix spike is outside its limits. A post-digestions spike is an example of an analytical spike.

2.5.2.4 Laboratory Control Samples (Verification Solutions)

A laboratory control sample (LCS), or a blank spike, is an aqueous or solid control sample of known composition that is analyzed using the same sample preparation, reagents, and analytical methods employed for the project samples. An LCS is obtained from an outside source or is prepared in the laboratory by spiking reagent water or a clean solid matrix for a stock solution that is different than that used for the calibration standards. The LCS is the primary indicator of process control used to demonstrate whether the sample preparation and analytical steps are in control, apart from sample matrix effects. LCSs contain the target analytes identified in the method.

2.5.2.5 Laboratory Duplicate Samples

Duplicate samples are samples that have been divided into two portions at some step in the measurement process. Each portion is then carried through the remaining steps of the process. Duplicate samples provide information on the precision of the operations involved. Analytical duplicates are a pair of subsamples from a field sample that are taken through the entire preparation and analysis procedure; any difference between the results indicates the precision of the entire method in the given matrix. Under the laboratory protocols, the matrix spike is duplicated to provide a matrix spike duplicate. Matrix spike duplicates will be prepared for every analytical batch of at least 10 samples. Analytical duplicates are prepared by taking two aliquots of a process sample and analyzing them in the same manner. Both matrix and analytical spike duplicates are used to monitor the precision of the analytical process.

2.5.2.6 Performance Evaluation Samples

Project-specific laboratory performance evaluations via performance evaluate samples are not anticipated as part of this site characterization, but may be performed at P4's option, or as directed by the oversight agencies/tribes, if analytical or validation exercises indicate the presence of potential laboratory QA issues.

2.6 INSTRUMENT/EQUIPMENT CALIBRATION AND MAINTENANCE REQUIREMENTS

2.6.1 Field Equipment

For this sampling program, there is no field equipment that will be used which requires calibration.

2.6.2 Laboratory Equipment

2.6.2.1 Instrumentation Requiring Calibration

All analytical measurement instruments and equipment used by the laboratories will be controlled by a formal calibration and preventive maintenance program. At a minimum, each laboratory program will require that equipment is of the proper type, range, accuracy, and precision to provide data compatible with specified requirements. All instruments and equipment that measure a quantity, or whose performance is expected at a stated level, are subject to calibration. In addition, each laboratory's preventive maintenance program will include the following, as a minimum:

- A listing of the instruments and equipment that will be used in the project
- The frequency of maintenance considering manufacturer's recommendations and previous experience with the equipment
- A file for each instrument containing a list of spare parts maintained, external contracts, and a listing of the items to be checked or serviced during maintenance

2.6.2.2 Calibration Methods

Physical and chemical calibrations will be performed within each laboratory as described in this subsection. Physical calibration refers to physical measurements that are made on equipment to verify or provide corrections to the observed data. Calibration acceptance criteria for analytical methods are summarized for EPA Methods 6020A, 7470A/7471A, 901.1M, and 903.1 on Tables 1-4 through 1-7, respectively. Physical calibrations will be documented on data sheets that are designed for each specific application. At a minimum, the information record will include the date, analyst, instrument identification, identification of reference standard, expected values, measured values, and correction factors, if applicable.

Chemical calibration or standardization refers to operations in which instrument response is related to analyzed concentration. The minimum requirements for chemical calibration will be as specified in the applicable method. Chemical calibrations consist of initial and continuing calibrations, which are documented in several ways depending on the type of instrument. For non-computerized data systems such as strip chart recorders and meter readouts, the instrument responses will be transcribed, along with other pertinent information, onto data sheets for each specific analysis. When computerized data systems are used, the data will be collected and stored in computer files, as well as hard-copy printouts, which may either be included with the data package or kept in a central record. With computerized data systems, the run logs provide a cross-reference to the calibration

runs. At a minimum, the information recorded for the calibrations will include the data, analyst, instrument identification, standard identification and concentrations, raw instrument responses, file descriptor, and calibration parameters such as regression coefficients, correlation coefficients, or response and calibration factors.

Initial calibration consists of the establishment of a calibration or standard curve, which associates instrument response and analyzed concentration. The curve is constructed by measuring the responses of a series of standard solutions containing the analytes of interest at known concentrations. This initial calibration will be verified each working day by measurement of one or more calibration standards.

2.6.2.3 Calibration Apparatus

The use of calibration apparatus will be according to the manufacturer's instructions or the laboratories' SOPs.

2.6.2.4 Calibration Standards

Primary standards will be obtained as either neat materials, which will be used to prepare stock standard solutions, or as prepared solutions to be used as stock standards. Records will be maintained on primary standards that include date of receipt, source, purity, composition, storage conditions, and expiration dates. Primary standards will be traceable to National Institute of Standards and Technology standards, or will be vendor-certified. The preparation of stock, intermediate, and working standard solutions will be documented in standards preparation logbooks. Each stock, intermediate, and working standard will be assigned a number to permit traceability of preparation from stock to working standards and to reference the analysis of the standards. Logbooks will be completed by the appropriate analysts as they prepare standards and will be subject to supervisory review. At a minimum, working standards will be labeled with preparation data, and the number or designation of the logbook where information on the standard is recorded. Measurements made during standards preparation will also be recorded.

2.6.2.5 Calibration Frequency

The frequency of instrument calibration will be according to the manufacturer's instructions and is summarized for EPA Methods 6020A, 7470A/7471A, 901.1M, and 903.1 on Tables 1-4 through 1-7, respectively.

2.7 DATA ACQUISITION, VALIDATION, REVIEW AND REPORTING

2.7.1 Field Data

Raw field measurements and observations will be entered in field notebooks. Sample collection information will be recorded on each chain-of-custody form. These documents and records will be reviewed for completeness by the Field Team Leader at the end of each day. The overall quality of the field data from any given sampling round will be further evaluated during the process of data validation as described below.

2.7.2 Laboratory Data Validation

Any anomaly or problem encountered during receipt, preparation, or analysis of samples will be documented in the laboratory's case narrative (see Section 1.6.3) as part of the hard-copy deliverable for each data package. The laboratories will establish calibration curves and calculation of sample concentrations from instrument responses. Raw laboratory data will be converted to sample concentrations using formulas defined by applicable laboratory SOPs. The calculations will be performed by computerized data systems interfaced to the instruments, by personal calculators, or through programs installed on stand-alone personal computers. Each laboratory analyst will be responsible for the reduction of the raw data that they generate. At a minimum, such activities will include:

- Reduction of raw data generated to reportable values
- An initial review of analytical and quality control data
- Performance of manual calculations and transfer of data onto forms, laboratory reports, and laboratory databases
- Preparation of computer files for instrumental calculations
- Generation of data forms for the analytical reports
- Copying of relevant forms and logs for inclusion in the laboratory reports
- Submittal of the laboratory report to a supervisor for a QA/QC review
- Resolution of discrepancies noted during the QA/QC review

For non-instrument methods and for methods using instruments without computerized data systems that require manual calculations, the responsible analyst will enter bench-generated data into bound laboratory workbooks with form-specific instrument responses, standard and spike concentrations, sample numbers, and other pertinent information. For instruments that are directly

coupled to computerized data systems, raw data consist of instrument responses in the form of printer output or computer-generated data files. Printer output will be filed by sample batch, and the data files archived on disk or magnetic tape. Computer data files will be identified by unique, sequential descriptors cross-referenced in the run logs to the analysis sequence. At a minimum, strip chart recordings will be labeled with the following information:

- Sample identification number
- Date and time of analysis
- Instrument identification
- Name of analyst(s)
- Applicable operational parameters
- Date file identification
- Positively identified elements or compounds

2.7.3 Data Verification and Validation

The following definitions are provided in *Guidance for Quality Assurance Project Plans* (USEPA, 2002):

- Verification – the process of evaluating the completeness, correctness, and conformance/compliance of a specific data set against the method, procedural, or contractual specifications.
- Validation – an analyte- and sample-specific process that extends the evaluation of data beyond method, procedural, or contractual compliance (i.e., data verification) to determine the analytical quality of a specific data set.

Based on these definitions, the 3rd-party validator technically will be performing data verification of the sample, calibration, and QC data provided by the laboratory against the criteria specified in this QAPP. The validator will use the *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (USEPA, 2004) and *Evaluation of Radiochemical Data Usability* (USDOE, 1997) as a basis for performing data verification and qualification of data. Where appropriate, specific references to the USEPA Functional Guidelines, as well as additional detail and/or deviation from that guidance, is detailed for EPA Methods 6020A, 7470A/7471A, 901.1M, and 903.1 on Tables 1-4 through 1-7, respectively. The validator will document the data verification process on their in-house worksheets and summarize the results in data validation reports (templates provided in Attachment C).

The validator will use the following data qualifiers (“USEPA Flag”):

- U The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit.
- J The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample.
- J+ The result is an estimated quantity, but the result may be biased high.
- J- The result is an estimated quantity, but the result may be biased low.
- R The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample.
- UJ The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise.

And the following “Reason Codes”:

- 1 Holding Time
- 2 Sample Preservation (including receipt temperature)
- 3 Sample Custody
- 4 Missing Deliverable
- 5 ICPMS Tune
- 6 Initial Calibration
- 7 Initial Calibration Verification
- 8 Continuing Calibration Verification
- 9 Low-Level Calibration Check Sample
- 10 Calibration Blank
- 11 Laboratory or Preparation Blank
- 12 ICPMS or ICP Interference Check Standard
- 13 Laboratory Control Sample or Laboratory Control Sample Duplicate Recovery
- 14 Laboratory Control Sample Precision
- 15 Laboratory Duplicate Precision
- 16 Matrix Spike or Matrix Spike Duplicate Recovery
- 17 Matrix Spike/Matrix Spike Duplicate Precision
- 18 ICPMS or ICP Serial Dilution
- 19 ICPMS Internal Standard
- 20 Field Replicate Precision
- 21 Equipment Rinsate Blank

- 22 Linear Range Exceeded
- 23 Other reason
- 24 Result is less than the MDC
- 25 Result is less than two times the error

The validator will populate an MWH-supplied EDD with the following data:

- Field Header “USEPA Flag”: Populate with USEPA flags specified above and in template reports.
- Field Header “Reason Code”: Populate with all applicable Reason Codes as specified above and in template reports.
- Field Header “Final Result”: Populate with the final, qualified result, including any adjustment based on blank contamination.

The validator will perform USEPA Stage 2B verification/validation (USEPA, 2009) on approximately 90 percent of sample data and USEPA Stage 4 verification/validation on the remaining 10 percent of sample data.

The MWH Program Quality Manager will take the lead on validating the verified data. Data will be tabulated and assessed against the screening values. The reporting limits associated with non-detected values will be reviewed against the screening limits to evaluate whether the reported results are sufficiently sensitive as compared to the screening values. Results that are estimated (J+ or J-) will be assessed for impact on data usability. Rejected results, as well as any sample that could not be collected or analyzed for any reason, will be evaluated, and a data-gap assessment will be performed and documented in the report.

2.7.4 Data Analysis and Reporting

A report will be prepared at the direction of the MWH Program Manager to address the information needs of P4 and regulatory agencies and tribes. Concentrations of equipment rinsate blank samples will be expressed in terms of weight per unit volume (mg/L) for metals and radioactive decay per volume (pCi/L) for Ra-226, K-40, and Th-232. Concentrations of solid matrices (soil and vegetation samples) will be expressed in terms of weight per unit weight of the dried sample (mg/kg dw) for metals and radioactive decay per weight of the dried sample (pCi/g dw) for Ra-226, K-40, and Th-232. The number of significant figures in the field and laboratory data presented in the final report will be consistent with the limits of uncertainty inherent in the measurement or analytical method. For the derivation of preliminary, risk-based benchmark concentrations, results are

reported to one significant figure. Therefore, two significant figures will be retained for inputs to the risk model to minimize rounding error.

2.7.5 Data Storage and Retrieval

All field and laboratory records with accompanying data assessment summary forms will be archived as part of the project quality records. All records will be stored for a minimum of five years. In addition, MWH will maintain an electronic database to support the hard-copy record system.

3.0 ASSESSMENT/OVERSIGHT

3.1 FIELD AUDIT

MWH's Quality Manager or designee will conduct an onsite systems audit of field sampling practices during sampling activities. Any nonconformance observed in the audit will be documented and resolved. The oversight agencies/tribes may request and/or carry out additional field audits.

3.2 LABORATORY AUDITS

As previously noted, laboratory performance audit samples will not be prepared for this site characterization. On-site audits of the laboratories are not scheduled to be conducted. ALS is certified via National Environmental Laboratory Accreditation Program (NELAP). The oversight agencies/tribes may request and/or carry out laboratory audits.

3.3 INDEPENDENT TECHNICAL REVIEW

An independent technical review will be performed by the Program Manager or designee for all draft and final project reports. All comments will be resolved and incorporated prior to any client submittals.

3.4 CORRECTIVE AND PREVENTIVE ACTION

Any nonconformance with approved FSP requirements that may be observed in the field audit will be promptly evaluated and resolved.

4.0 REFERENCES

- United States Department of Energy (USDOE, 1997). *Evaluation of Radiochemical Data Usability*, es/er/ms-5. April.
- United States Environmental Protection Agency (USEPA), 2002. *Guidance for Quality Assurance Project Plans*. EPA/240/R-02/009. Prepared by the USEPA Office of Environmental Information, Washington, DC. December.
- USEPA, 2010. *USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review*. EPA 540-R-10-011. Prepared by USEPA Office of Superfund Remediation and Technology Innovation, Washington, DC. January.
- USEPA, 2006. *Guidance on Systematic Planning Using the Data Quality Objective Process*. EPA/240/B-06/001. Prepared by the USEPA Office of Environmental Information, Washington, DC. February.
- USEPA, 2009. *Guidance for Labeling Externally Validated Laboratory Analytical Data for Superfund Use*. EPA 45-R-08-005. Office of Solid Waste and Emergency Response. January 13.

FIGURES

FED EX #: _____COOLER #: _____LAB: ALS, 225 Commercial Dr., Ft. Collins, CO 80524

SAMPLER(S) PRINTED NAME AND SIGNATURE

PROJECT NAME: P4 Production LLC - Radiological and Background Investigation

PROJECT NUMBER: Direct bill to Monsanto

Laboratory ID	FIELD SAMPLE IDENTIFICATION	DATE	TIME	MATRIX	ICPMS Metals (6020A) (1,2)	Mercury (soil; 7471A) (1)	Mercury (water; 7470A)	Uranium (6020A) (1)	Ra-226, K-40 & Th-232 (soil; 901.1M)	Ra-226 (water; 903.1) (3)	K-40 & Th-232 (water; 901.1) (3)	Comments

Comments/Instructions:
1 Soil samples for metals analysis are to be dried and sieved prior to digestion.
2 ICPMS metals are Sb, As, B, Cd, Cr, Co, Cu, Mn, Mo, Ni, Se, Ag, Tl, U, V, and Zn.
3 Samples need to be sealed for a minimum of 25 days from collection prior to analysis. Soil samples for radionuclide analysis are to be dried and sieved prior to analysis.

Signature:	Print Name:	Company Name/Title:	Date:
RELINQUISHED BY:			
RECEIVED BY:			
RELINQUISHED BY:			
RECEIVED BY:			

For Lab Use Only: Sample Condition Upon Receipt:

FIELD CHANGE REQUEST	
Project Reference:	FCR No.:
Task description:	
Affected plan or procedures:	
Requested variation(s):	
Justification:	
Requested by:	Date:
Field change authorized by:	Date:
Approved by:	Date:
Approved by:	Date:
Comments:	




Figure 1-2
Field Change Request Form

TABLES

TABLE 1-1

SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
 (Page 1 of 10)

						Analytical/Radiological Method							
Area	Field Sample Identification ^a	Location ^a	Matrix	Sample Type	Sample Type	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
<u>Background COPC Investigation:</u>													
Caldwell Canyon	1407-MCC-MP01-SS-1	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP01-SS-2	Background, Meade Peak	Soil	Composite	Duplicate		X	X	X				
Caldwell Canyon	1407-MCC-MP02-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP03-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP04-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP05-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP06-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP07-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP08-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP09-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-MP10-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC01-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC02-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC03-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC04-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC05-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC06-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC07-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC08-SS-1	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC08-SS-2	Background, Rex Chert	Soil	Composite	Duplicate		X	X	X				
Caldwell Canyon	1407-MCC-RC09-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-RC10-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-WF01-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-WF02-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-WF03-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-WF04-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-WF05-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-DW01-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-DW02-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-DW03-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-DW04-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Caldwell Canyon	1407-MCC-DW05-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				

TABLE 1-1

SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
 (Page 2 of 10)

						Analytical/Radiological Method							
Area	Field Sample		Matrix	Sample Type	Sample Type	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rn-222 (Radon) (soil; 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
	Identification ^a	Location ^a											
<u>Background COPC Investigation:</u>													
Blackfoot Bridge	1407-MBF-MP01-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP02-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP03-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP04-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP05-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP06-SS-1	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP06-SS-2	Background, Meade Peak	Soil	Composite	Duplicate		X	X	X				
Blackfoot Bridge	1407-MBF-MP07-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP08-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP09-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-MP10-SS	Background, Meade Peak	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC01-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC02-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC03-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC04-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC05-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC06-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC07-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC08-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC09-SS-1	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-RC09-SS-2	Background, Rex Chert	Soil	Composite	Duplicate		X	X	X				
Blackfoot Bridge	1407-MBF-RC10-SS	Background, Rex Chert	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-WF01-SS-1	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-WF01-SS-2	Background, Wells Formation	Soil	Composite	Duplicate		X	X	X				
Blackfoot Bridge	1407-MBF-WF02-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-WF03-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-WF04-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-WF05-SS	Background, Wells Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-DW01-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-DW02-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-DW03-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-DW04-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				
Blackfoot Bridge	1407-MBF-DW05-SS	Background, Dinwoody Formation	Soil	Composite	Primary		X	X	X				

TABLE 1-1
SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 3 of 10)

						Analytical/Radiological Method							
	Field Sample			Sample	Sample	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Identification ^a	Location ^a	Matrix	Type	Type								
<u>Radiological Correlation Study:</u>													
On-Site	1407-MOS-01-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-02-SS-1	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-02-SS-2	On-Site	Soil	Composite	Duplicate	X	X						
On-Site	1407-MOS-03-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-04-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-05-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-06-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-07-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-08-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-09-SS	On-Site	Soil	Composite	Primary	X	X						
On-Site	1407-MOS-10-SS	On-Site	Soil	Composite	Primary	X	X						
Background	1407-MBK-01-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-02-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-03-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-04-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-05-SS-1	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-05-SS-2	Background	Soil	Composite	Duplicate	X	X						
Background	1407-MBK-06-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-07-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-08-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-09-SS	Background	Soil	Composite	Primary	X	X						
Background	1407-MBK-10-SS	Background	Soil	Composite	Primary	X	X						

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 4 of 10)**

						Analytical/Radiological Method							
	Field Sample			Sample	Sample	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Identification ^a	Location ^a	Matrix	Type	Type								
<u>Radon Flux Study:</u>													
On-Site	1407-MOS1-01-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-02-RN-1	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-02-RN-2	On-Site Area 1	Air	Discrete	Duplicate					X			
On-Site	1407-MOS-03-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-04-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-05-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-06-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-07-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-08-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-09-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-10-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-11-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-12-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-13-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-14-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS-15-RN	On-Site Area 1	Air	Discrete	Primary					X			
On-Site	1407-MOS2-01-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-02-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-03-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-04-RN-1	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-04-RN-2	On-Site Area 2	Air	Discrete	Duplicate					X			
On-Site	1407-MOS2-05-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-06-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-07-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-08-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-09-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-10-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-11-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-12-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-13-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-14-RN	On-Site Area 2	Air	Discrete	Primary					X			
On-Site	1407-MOS2-15-RN	On-Site Area 2	Air	Discrete	Primary					X			

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 5 of 10)**

						Analytical/Radiological Method							
Area	Field Sample		Matrix	Sample		ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
	Identification ^a	Location ^a		Type	Type								
<u>Radon Flux Study:</u>													
On-Site	1407-MOS3-01-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-02-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-03-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-04-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-05-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-06-RN-1	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-06-RN-2	On-Site Area 3	Air	Discrete	Duplicate					X			
On-Site	1407-MOS3-07-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-08-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-09-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-10-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-11-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-12-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-13-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-14-RN	On-Site Area 3	Air	Discrete	Primary					X			
On-Site	1407-MOS3-15-RN	On-Site Area 3	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW01-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW02-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW03-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW04-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW05-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW06-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW07-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW08-RN-1	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW08-RN-2	Background, Dinwoody	Air	Discrete	Duplicate					X			
Caldwell Canyon	1407-MCC-DW09-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW10-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW11-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW12-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW13-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW14-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-DW15-RN	Background, Dinwoody	Air	Discrete	Primary					X			

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 6 of 10)**

						Analytical/Radiological Method							
						ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Field Sample Identification ^a	Location ^a	Matrix	Sample Type	Sample Type								
<u>Radon Flux Study:</u>													
Caldwell Canyon	1407-MCC-MP01-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP02-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP03-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP04-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP05-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP06-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP07-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP08-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP09-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP10-RN-1	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP10-RN-2	Background, Meade Peak	Air	Discrete	Duplicate					X			
Caldwell Canyon	1407-MCC-MP11-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP12-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP13-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP14-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-MP15-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC01-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC02-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC03-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC04-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC05-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC06-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC07-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC08-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC09-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC10-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC11-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC12-RN-1	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC12-RN-2	Background, Rex Chert	Air	Discrete	Duplicate					X			
Caldwell Canyon	1407-MCC-RC13-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC14-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-RC15-RN	Background, Rex Chert	Air	Discrete	Primary					X			

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 7 of 10)**

						Analytical/Radiological Method							
	Field Sample			Sample	Sample	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Identification ^a	Location ^a	Matrix	Type	Type								
<u>Radon Flux Study:</u>													
Caldwell Canyon	1407-MCC-WF01-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF02-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF03-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF04-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF05-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF06-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF07-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF08-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF09-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF10-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF11-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF12-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF13-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF14-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Caldwell Canyon	1407-MCC-WF14-RN-2	Background, Wells Formation	Air	Discrete	Duplicate					X			
Caldwell Canyon	1407-MCC-WF15-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW01-RN-1	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW01-RN-2	Background, Dinwoody	Air	Discrete	Duplicate					X			
Blackfoot Bridge	1407-MBF-DW02-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW03-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW04-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW05-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW06-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW07-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW08-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW09-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW10-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW11-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW12-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW13-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW14-RN	Background, Dinwoody	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-DW15-RN	Background, Dinwoody	Air	Discrete	Primary					X			

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 8 of 10)**

						Analytical/Radiological Method							
	Field Sample			Sample	Sample	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Identification ^a	Location ^a	Matrix	Type	Type								
<u>Radon Flux Study:</u>													
Blackfoot Bridge	1407-MBF-MP01-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP02-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP03-RN-1	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP03-RN-2	Background, Meade Peak	Air	Discrete	Duplicate					X			
Blackfoot Bridge	1407-MBF-MP04-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP05-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP06-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP07-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP08-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP09-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP10-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP11-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP12-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP13-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP14-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-MP15-RN	Background, Meade Peak	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC01-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC02-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC03-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC04-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC05-RN-1	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC05-RN-2	Background, Rex Chert	Air	Discrete	Duplicate					X			
Blackfoot Bridge	1407-MBF-RC06-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC07-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC08-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC09-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC10-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC11-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC12-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC13-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC14-RN	Background, Rex Chert	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-RC15-RN	Background, Rex Chert	Air	Discrete	Primary					X			

TABLE 1-1

**SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 9 of 10)**

						Analytical/Radiological Method							
	Field Sample			Sample	Sample	ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil, 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)
Area	Identification ^a	Location ^a	Matrix	Type	Type								
<u>Radon Flux Study:</u>													
Blackfoot Bridge	1407-MBF-WF01-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF02-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF03-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF04-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF05-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF06-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF07-RN-1	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF07-RN-2	Background, Wells Formation	Air	Discrete	Duplicate					X			
Blackfoot Bridge	1407-MBF-WF08-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF09-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF10-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF11-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF12-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF13-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF14-RN	Background, Wells Formation	Air	Discrete	Primary					X			
Blackfoot Bridge	1407-MBF-WF15-RN	Background, Wells Formation	Air	Discrete	Primary					X			
<u>Equipment Rinsate Samples:</u>													
na	1407-ER-SS-01	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-02	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-03	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-04	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-05	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-06	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-07	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-08	na	Water	na	ER			X			X	X	X
na	1407-ER-SS-09	na	Water	na	ER			X			X	X	X

TABLE 1-1
SAMPLES TO BE COLLECTED
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 10 of 10)

Area	Field Sample Identification ^a	Location ^a	Matrix	Sample Type	Sample Type	Analytical/Radiological Method							
						ICPMS Uranium (soil; 6020A)	Ra-226, K-40, & Th-232 (soil; 901.1M)	ICPMS Metals (soil; 6020A) ^b	Mercury by CVAA (soil; 7471A)	Rm-222 (Radon) (soil; 115)	Mercury (water; 7470A)	Radium-226 (water; 903.1)	K-40 & Th-232 (water; 901.1)

^a As stated in Section 1.4.2 of the QAPP, the actual sample collection location (and, consequently, the field sample identification) for the correlation study will be based on the field survey.

^b ICPMS metals are Sb, As, B, Cd, Cr, Co, Cu, Mn, Mo, Ni, Se, Ag, Tl, U, V, and Zn.

COPC - constituent of potential concern

CVAA - cold vapor atomic absorption

ER - equipment rinsate blank sample

ICPMS - inductive coupled plasma/mass spectrometry

na - not applicable

TABLE 1-2

**ACHIEVABLE LABORATORY LIMITS AND APPLICABLE PROJECT SCREENING VALUES
RADIOLOGICAL AND BACKGROUND INVESTIGATION
(Page 1 of 2)**

Method	Sampling Parameter	Units	Soil Screening Levels for Human Health and Ecological Receptors							
			Achievable Laboratory Limits ¹		Residential USEPA Regional Screening Levels for Soil ²		Eco-SSL ³			
					Residential	Industrial	Plants	Soil Invert.	Avian	Mam-malian
EPA 6020A	Antimony	mg/kg	0.0300	0.01	31	410	--	78	--	0.27
	Arsenic	mg/kg	0.200	0.06	0.61	2.4	18	--	43	46
	Boron	mg/kg	5.00	1.5	16,000	200,000	--	--	--	--
	Cadmium	mg/kg	0.0300	0.012	70	800	32	140	0.77	0.36
	<u>Chromium, total:</u>	mg/kg	1.00	0.009	--	--	--	--	--	--
	Chromium III	mg/kg	--	--	120,000	1,500,000	--	--	26	34
	Chromium VI	mg/kg	--	--	230	3,100	--	--	--	130
	Cobalt	mg/kg	0.100	0.03	23	--	13	--	120	230
	Copper	mg/kg	1.00	0.3	3,100	41,000	70	80	28	49
	Manganese	mg/kg	0.200	0.06	1,800	23,000	220	450	4,300	4,000
	Molybdenum	mg/kg	0.100	0.05	390	5,100	--	--	--	--
	Nickel	mg/kg	0.500	0.15	1,500	20,000	38	280	210	130
	Selenium	mg/kg	0.100	0.05	390	5,100	0.52	4.1	1.2	0.63
	Silver	mg/kg	0.0100	0.003	390	5,100	560	--	4.2	14
	Thallium	mg/kg	0.0200	0.006	0.78	10	--	--	--	--
	Uranium	mg/kg	0.0100	0.003	230	3,000	--	--	--	--
	Vanadium	mg/kg	0.100	0.03	390	5,100	--	--	7.8	280
	Zinc	mg/kg	2.00	0.25	23,000	310,000	160	120	46	79
EPA 7471A	Mercury	mg/kg	0.0330	0.005	23	310	--	--	--	--
EPA 901.1M	Radium-226 ⁴	pCi/g	1	NA	--	--	--	--	--	--
	Potassium-40	pCi/g	10	NA	--	--	--	--	--	--
	Thorium-232	pCi/g	1	NA	--	--	--	--	--	--
EPA 115	Radon-222	pCi/m ² s	20	NA	--	--	--	--	--	--

TABLE 1-2

**ACHIEVABLE LABORATORY LIMITS AND APPLICABLE PROJECT SCREENING VALUES
RADIOLOGICAL AND BACKGROUND INVESTIGATION**

(Page 2 of 2)

- - no screening level established

¹ Generally achievable laboratory reporting limits; method detection limits may vary annually. Since the method will be performed on dried samples, the basis for these RLs (and MDCs for Ra-226, K-40, and Th-232) can be considered dry weight.

² May 2013 USEPA Residential Soil Regional Screening Level (RSL) for chemical contaminants; units are mg/kg, dry weight.

³ EPA ecological soil screening levels (SSL); units are mg/kg, dry weight.

⁴ An applicable screening limit is the Uranium Mill Tailings Radiation Control Act (UMTRCA) level of 5 pCi/g.

MDC - minimum detectable concentration

MDL - method detection limit

mg/kg - milligrams per kilogram

NA - not applicable

pCi/g - picocuries per gram

RL - reporting limit

TABLE 1-3

**PROJECT PERFORMANCE MEASUREMENT CRITERIA
RADIOLOGICAL AND BACKGROUND INVESTIGATION**

DQI	Criteria	Project-Specific Goal
Detection levels	The analytical detection levels should be less than the applicable screening criteria.	The achievable laboratory reporting limits and method detection limits for soil samples are listed on Table 1-2. Laboratory reporting limits are less than all screening levels. As stated in Section 1.4.2, the soil data produced from the radiological correlation study and background investigation will not be screened against these values; the screening levels are presented to ensure that the laboratory reporting limits are sufficiently sensitive at the level of interest for these target parameters.
Accuracy	Spiked target analytes should be recovered within the limits established for each target analyte.	Recoveries of target analytes spiked into laboratory control samples, matrix spike samples, and low-level calibration samples should be within the control limits specified on Tables 1-4 through 1-7 for those quality control samples.
Precision	Measured values of target analytes should be reproducible within the limits established for each target analytes.	Relative percent differences (RPDs) measured between laboratory control samples and laboratory control sample duplicates & matrix spike and matrix spike duplicates should be within the control limits specified on Tables 1-4 through 1-7 for those quality control samples. The RPDs for field duplicate samples should be assessed as described in Section 1.4.4.1.
Completeness	Each sample that is planned to be collected should be collected, analyzed, reported, and validated for each target analyte as specified in Section 1.4.2, except where actual site conditions prevent collection of sample as planned.	A minimum of 90% of planned soil will be collected. All target analytes will be tested, reported, and validated for each collected sample.

TABLE 1-4

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 6020A (ICPMS)
(Page 1 of 4)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section ^a	Data Validation Qualification ^b
MS tuning sample	Prior to initial calibration, solution as specified in Section 7.10 of method (e.g., ⁷ Li, ⁵⁹ Co, ¹¹⁵ In, and ²⁰⁵ Tl)	Mass calibration d 0.1 amu from the true value. Resolution < 0.9 amu full width at 10% peak height. Stability: RSD d 5% for at least three replicate analysis.	Retune instrument then reanalyzing tuning solution.	Per Section II of ICP-MS NFG, except substitute with method acceptance limits.	RSD > 5% = J/UJ (professional judgment on criteria related to non-target analytes).
Initial calibration (ICAL) for all target analytes (minimum one standard and a blank)	Daily initial calibration prior to sample analysis	If more that one standard is used, correlation coefficient (r) ≥ 0.995	Correct problem then repeat initial calibration.	Per Section III of ICP-MS NFG.	r < 0.995 = J/UJ
Initial Calibration Verification (ICV)	After ICAL, before beginning a sample run (at a concentration other than used for calibration and from a second source)	All analytes within ±10% of expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Per Section III of ICP-MS NFG.	%R < 90 or >110% = J/UJ
Initial Calibration Blank (ICB)	After ICV	No analyte detected ≥ RL	Correct problem and reanalyze.	Per Section IV of ICPMS NFG, except U at detected value if result > MDL < RL.	Per Table 14 in NFG, except U at detected value if result > MDL < RL.
Low-Level Calibration Check Standard (LLCCS)	Daily, after ICAL (at a concentration d RLs).	All analytes (except Sb, Cd, Co, Cu, Ni, Se, Tl, and U) within ±30% of expected value. Sb, Cd, Co, Cu, Ni, Se, Tl, and U within ±50% of expected value.	Correct problem then reanalyze.	Per Section III of ICP-MS NFG.	%R < 70% or > 130% (%R < 50% or > 150% for Sb, Tl, or U) = J/UJ

TABLE 1-4

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 6020A (ICPMS)
(Page 2 of 4)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section ^a	Data Validation Qualification ^b
Interference Check Solution A & AB (ICS-A & ICS-AB)	At the beginning of an analytical run or once during a 12-hour period, whichever is more frequent	ICS-A: All non-spiked analytes < RL. ICS-AB: All non-spiked analytes < RL.	Correct problem and reanalyze ICS-A and ICS-AB.	Per Section III of ICP-MS NFG.	ICS < 80% or > 120% = J/UJ
Continuing Calibration Verification (CCV)	After every 10 samples and at the end of the analysis sequence (at a mid-calibration range concentration)	The analyte within $\pm 10\%$ of expected value	Correct problem then repeat CCV and reanalyze all samples since last successful CCV.	Per Section III of ICP-MS NFG.	CCV < 90 or > 110% = J/UJ
Continuing Calibration Blank (CCB)	Before beginning a sample run, after every 10 samples, and at end of the analytical sequence	No analyte detected \geq RL	Correct problem then reanalyze calibration blank and previous 10 samples. Apply "B" flag to all associated positive results for the specific analyte(s) as appropriate.	Per Section IV of ICPMS NFG, except U at detected value if result > MDL < RL.	Per Table 14 in NFG, except U at detected value if result > MDL < RL.
Method blank (or preparation blank)	One per analytical batch	No analyte detected \geq RL	Assess data. Correct problem. If necessary, reprep and analyze method blank and all samples processed with the contaminated blank. Apply B-flag to all associated positive results for the specific analyte(s) in the preparation batch.	Per Section IV of ICPMS NFG, except U at detected value if result > MDL < RL.	Per Table 14 in NFG, except U at detected value if result > MDL < RL.

TABLE 1-4

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 6020A (ICPMS)
(Page 3 of 4)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section ^a	Data Validation Qualification ^b
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	Vendor-specified or laboratory-determined control limits (but not wider than 80-120% recovery). If LCS/LSC duplicate (LCSD) used, then use RPD d 20.	Correct problem then reanalyze. If still out, re-prepare and reanalyze the LCS and all samples in the preparation batch.	Per Section VI of ICP-MS NFG, except substitute 80-120% recovery and d 20 RPD limits.	%R < 80 or > 120% for water = J/UJ; < 50% = J detects, R non-detects
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One MS/MSD per every 20 samples per matrix	Laboratory-determined control limits (but not wider than 75-125% recovery and RPD d 20).	Flag associated sample results and perform post-digestion spike addition.	Per Section VIII of ICP-MS NFG, except substitute 75-125% recovery and d 20 RPD limits.	%R < 75 or > 125% for water = J/UJ; < 30% = J detects, R non-detects. Water RPD <20%, soil < 35%. Low level (< 5 X RL, use \pm RL water, 2 X RL for soil). For MS, if %R < 30% and post spike < 75% or not run, J detects, R non-detects. If post spike > 75 %, UJ non-detects.
Post-digestion spike addition	If MS/MSD fails	Recovery within 75-125% of expected results.	Perform dilution test.	Not applicable	None; see dilution test.
Serial dilution (SD) test	One SD sample per every 20 samples (required for samples containing concentrations > 50 X MDL)	Fivefold (1+4) dilution must agree within $\pm 10\%$ of the original determination.	Flag associated sample results and discuss in case narrative.	Per Section IX of ICPMS NFG.	%D < 90 > 110% = J/UJ

TABLE 1-4

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 6020A (ICPMS)
(Page 4 of 4)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section ^a	Data Validation Qualification ^b
Internal Standards (ISs)	Every sample; internal standards selected from list specified in Section 1.4 of method.	IS intensity e 70% < 130% of intensity of the IS in the ICAL.	Perform corrective action as described in Section 9.6 of method.	Per Section X of ICP-MS NFG, except substitute 70-130 % limits.	IS %R < 70% > 130 % = J/UJ
Concentrations between the MDL and RL	All samples	Not applicable	Flag as estimated value ("J" flag)	Not applicable	Not applicable

^a National Functional Guidelines (NFG) for Inorganic Data Review (USEPA, 2004).

^b Refer to NFG for detailed evaluation protocols.

ICPMS – inductively coupled plasma/mass spectrometry

MDL – method detection limit

RL – reporting limit

RPD – relative percent difference

RSD – relative standard deviation

TABLE 1-5

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 7470A/7471A (CVAA)
(Page 1 of 3)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section^a	Data Validation Qualification^b
Initial calibration (ICAL) for all target analytes (minimum five standards and a blank)	Daily initial calibration prior to sample analysis	Blank plus five calibration concentrations, correlation coefficient (r) ≥ 0.995	Correct problem then repeat initial calibration.	Per Section II of AA NFG.	$r < 0.995 = J/UJ$
Initial Calibration Verification (ICV)	After ICAL, before beginning a sample run (at a concentration other than used for calibration and from a second source)	All analytes within $\pm 20\%$ of expected value	Correct problem and verify second source standard. Rerun ICV. If that fails, correct problem and repeat ICAL.	Per Section II of AA NFG.	$\%R < 80$ or $> 120\% = J/UJ$
Initial Calibration Blank (ICB)	After ICV	No analyte detected $\geq RL$	Correct problem and reanalyze.	Per Section III of AA NFG, except U at detected value if result $> MDL < RL$.	Per Table 24 in NFG, except U at detected value if result $> MDL < RL$.
Low-Level Calibration Check Standard (LLCCS)	Daily, after ICAL (at a concentration d RLs).	The analyte(s) within $\pm 30\%$ of expected value.	Correct problem then reanalyze.	Per Section II of AA NFG.	$\%R < 70\%$ or $> 130\% = J/UJ$
Continuing Calibration Verification (CCV)	After every 10 samples and at the end of the analysis sequence (at a mid-calibration range concentration)	The analyte within $\pm 20\%$ of expected value	Correct problem then repeat CCV and reanalyze all samples since last successful CCV.	Per Section II of AA NFG.	$CCV < 80$ or $> 120\% = J/UJ$

TABLE 1-5

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 7470A/7471A (CVAA)
(Page 2 of 3)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section^a	Data Validation Qualification^b
Method blank (or preparation blank)	One per analytical batch	No analyte detected \geq RL	Assess data. Correct problem. If necessary, reprep and analyze method blank and all samples processed with the contaminated blank. Apply B-flag to all associated positive results for the specific analyte(s) in the preparation batch.	Per Section III of AA NFG, except U at detected value if result $>$ MDL $<$ RL.	Per Table 24 in NFG, except U at detected value if result $>$ MDL $<$ RL.
Laboratory Control Sample (LCS) for all analytes	One LCS per analytical batch	Vendor-specified or laboratory-determined control limits (but not wider than 80-120% recovery). If LCS/LSC duplicate (LCSD) used, then use RPD d 20.	Correct problem then reanalyze. If still out, re-prepare and reanalyze the LCS and all samples in the preparation batch.	Per Section IV of AA NFG, except substitute 80-120% recovery and d 20 RPD limits.	%R $<$ 80 or $>$ 120% for water = J/UJ; $<$ 50% = J detects, R non-detects
Matrix Spike/Matrix Spike Duplicate (MS/MSD)	One MS/MSD per every 20 samples per matrix	Laboratory-determined control limits (but not wider than 80-120% recovery and RPD d 20).	Flag associated sample results and perform post-digestion spike addition.	Per Section VI of AA NFG, except substitute 75-125% recovery and d 20 RPD limits.	%R $<$ 75 or $>$ 125% for water = J/UJ; $<$ 30% = J detects, R non-detects. Water RPD $<$ 20%, soil $<$ 35%. Low level ($<$ 5 X RL, use \pm RL water, 2 X RL for soil). For MS, if %R $<$ 30% and post spike $<$ 75% or not run, J detects, R non-detects. If post spike $>$ 75 %, UJ non-detects.
Concentrations between the MDL and RL	All samples	Not applicable	Flag as estimated value ("J" flag)	Not applicable	Not applicable

TABLE 1-5

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR EPA METHOD 7470A/7471A (CVAA)
(Page 3 of 3)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Reference Section ^a	Data Validation Qualification ^b
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^a National Functional Guidelines (NFG) for Inorganic Data Review (USEPA, 2004).

^b Refer to NFG for detailed evaluation protocols.

AA – atomic absorption

CVAA – cold vapor atomic absorption

MDL – method detection limit

RL – reporting limit

RPD – relative percent difference

%R – percent recovery

TABLE 1-6

**SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RA-226, K-40 and TH-232 BY GAMMA SPECTROSCOPY (EPA 901.1M)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
(Page 1 of 3)**

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Procedure	Data Validation Qualification
Sample Handling of Soil Samples	Each sample at time of collection	No regulatory holding time.	NA	NA	NA
Initial Calibration (ICAL) Efficiency Determination for Ra-226, K-40 & Th-232	Yearly, for counting geometry	Use NIST-traceable standard (usually a mixed gamma source with multiple energies). Calibrate for each physical form annually. Do annual FWHM calibration per detector.	Correct problem, reanalyze.	Verify percent difference for the measured efficiency is ≤ 5 .	Reject sample results if standard is not NBS- or NIST-traceable or percent difference of fitted value > 5 .
Background Calibration for Ra-226, K-40 & Th-232	Weekly	Measure activity when no sample in the detector shield.	Clean detector, rerun.		
Method blank (or preparation blank)	One per analytical batch	Method blank $< \text{MDC}$.	Reanalyze; if still fails, re-prepare sample batch.	Verify method blank results is $< \text{MDC}$. Calculate NAD.	If method blank is $\geq \text{MDC}$, then flag sample as U. If $\text{NAD} > 2.58$, no action; if between 1.96 and 2.58, then J; if < 1.96 , consider R.
Daily energy calibration check and monitor FWHM and efficiency	Daily prior to sample analysis;	Create efficiency and background control charts (use approximately 20 points) for daily efficiencies and background checks. Acceptance criterion is ± 2 sigma error (warning limits); ± 3 sigma error indicates failure.	Correct problem, reanalyze. If still out, recalibrate.	Confirm items listed on data validation report template (Attachment C). Tolerance chart or statistical control chart of the appropriate efficiencies and background activities within ± 3 sigma error.	Reject sample results if results were generated from initial calibration with greater than or equal to ± 3 sigma error.

TABLE 1-6

**SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RA-226, K-40 and TH-232 BY GAMMA SPECTROSCOPY (EPA 901.1M)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
(Page 2 of 3)**

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Procedure	Data Validation Qualification
Laboratory Duplicate	One laboratory duplicate per preparation batch	Duplicate error ratio (DER) ≤ 2.13	Reanalyze; if still fails, re-prepare sample batch.	Verify DER and/or RPD is within control limits	If DER > 2.13 and/or RPD > 20, then evaluated results. If result(s) $\leq 5 \times$ MDC, then J. If result(s) < 5x MDC, and absolute difference is within $\pm 2 \times$ MDC, then no flag; if > $\pm 2 \times$ MDC, then J/UJ.
Laboratory Control Sample (LCS) for all analytes	One LCS per preparation batch	75-125% recovery	Reanalyze; if still fails, re-prepare sample batch.	Verify %Rs are within control limits	%R < 75 or > 125% = J/UJ; < 50% = J detects, R non-detects
Sample Reporting	Each sample in picoCurries per gram (pCi/g)	Report activity achieved ± 2 sigma total propagated uncertainty (TPU). If activity achieved is less than the minimum detectable activity (MDA) or minimum detectable concentration (MDC), the report the radionuclide as "BDL" (below detection limit).	Do not report results that are either (a) < MDC, or (b) 2x uncertainty	Verify sample results against MDCs and 2x uncertainty.	If sample result < MDC, then U at MDC. If sample result < 2x uncertainty, then U at MDC if < MDC or U at reported value if \leq MDC.

TABLE 1-6

**SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RA-226, K-40 and TH-232 BY GAMMA SPECTROSCOPY (EPA 901.1M)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
(Page 3 of 3)**

MDC – minimum detectable concentration
NA – not applicable
RPD – relative percent difference

Normalized absolute differences (NAD) Calculation:

$$\text{NAD} = \frac{\bullet [\text{Sample}] - [\text{Blank}] \bullet}{(\text{Uncertainty}_{\text{sample}}^2 + \text{Uncertainty}_{\text{blank}}^2)^{1/2}}$$

Where: [Sample] = sample concentration
[Blank] = blank concentration

Duplicate error ratio (DER) Calculation:

$$\text{DER} = \frac{\bullet ([\text{Sample}] - [\text{Duplicate}]) \bullet}{([2 \text{ sigma error}_{\text{Sample}}^2] + [2 \text{ sigma error}_{\text{Duplicate}}^2])^{1/2}}$$

Where: [Sample] = sample concentration
[Duplicate] = duplicate concentration

TABLE 1-7

**SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RADIUM-226 BY RADON EMANATION TECHNIQUE (EPA 903.1)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
(Page 1 of 3)**

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Procedure	Data Validation Qualification
Sample Handling	Each sample at time of collection	Preserve with 1N nitric acid to pH < 2. If not preserved at time of collection, they should be brought to the laboratory within 5 days, then preserved and held in the original container for a minimum of 16 hours before analysis or transfer of the sample.	Flag sample results, as needed.	Evaluate preservation and holding times against criteria.	Flag as estimated (J/UJ) if samples were not properly preserved or holding time exceeded. Reject data if gross exceedance.
Initial Calibration (ICAL) Efficiency Determination for Ra-226	As needed, per Section 7.1 of method	Use NIST-traceable standard reference material for Ra-226. Calculate the calibration constant for the de-emanation system and the scintillation cell (counts per minute) divided by the disintegrations per minute of Rn-222. Each fitted value d 5 percent difference.	Correct problem then repeat initial calibration.	Confirm items listed on data validation report template (Attachment C).	Reject sample results if standards are not NBS- or NIST-traceable.
Daily Efficiency and Background Check for Ra-226	Daily prior to sample analysis;	Create efficiency and background control charts (use approximately 20 points) for daily efficiencies and background checks. Acceptance criterion is ± 2 sigma error (warning limits); ± 3 sigma error indicates failure.	Correct problem, reanalyze. If still out, recalibrate.	Confirm items listed on data validation report template (Attachment C). Tolerance chart or statistical control chart of the appropriate efficiencies and background activities within ± 3 sigma error.	Reject sample results if results were generated from initial calibration with greater than or equal to ± 3 sigma error.
Method blank (or preparation blank)	One per analytical batch	Sample results are at least 5x the measured blank activity or all sample results are less than the reported method blank activity, qualify data.	Reanalyze; if still fails, re-prepare sample batch.	Verify method blank results is < MDC. Calculate NAD.	If method blank is e MDC, then flag sample as U. If NAD > 2.58, no action; if between 1.96 and 2.58, then J; if < 1.96, consider R.

TABLE 1-7

SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RADIUM-226 BY RADON EMANATION TECHNIQUE (EPA 903.1)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
 (Page 2 of 3)

Quality Control Check	Minimum Frequency	Acceptance Criteria	Corrective Action/Lab Flagging Criteria	Data Validation Procedure	Data Validation Qualification
Laboratory Duplicate	One laboratory duplicate per preparation batch	Duplicate error ratio (DER) ≤ 2.13	Reanalyze; if still fails, re-prepare sample batch.	Verify DER and/or RPD is within control limits	If DER > 2.13 and/or RPD > 20, then evaluate results. If result(s) $\leq 5 \times \text{MDC}$, then J. If result(s) < $5 \times \text{MDC}$, and absolute difference is with $\pm \text{MDC}$ (water) or $\pm 2 \times \text{MDC}$ (soil), then no flag; if > $\pm \text{MDC}$ (water) or $\pm 2 \times \text{MDC}$ (soil), then J/UJ.
Laboratory Control Sample (LCS) for all analytes	One LCS per preparation batch	75-125% recovery	Reanalyze; if still fails, re-prepare sample batch.	Verify %Rs are within control limits	%R < 75 or > 125% = J/UJ; < 50% = J detects, R non-detects
Sample Reporting	Each sample in picoCurries per gram (pCi/g)	Report activity achieved ± 2 sigma total propagated uncertainty (TPU). If activity achieved is less than the minimum detectable activity (MDA) or minimum detectable concentration (MDC), the report the radionuclide as "BDL" (below detection limit).	Not applicable	Verify sample results against MDCs and 2x uncertainty.	If sample result < MDC, then U at MDC. If sample result < 2x uncertainty, then U at MDC if < MDC or U at reported value if $\leq \text{MDC}$.

TABLE 1-7

**SUMMARY OF CALIBRATION AND QC PROCEDURES FOR RADIUM-226 BY RADON EMANATION TECHNIQUE (EPA 903.1)
SOUTHEAST IDAHO MINE SITES, P4 MONSANTO
(Page 3 of 3)**

MDC – minimum detectable concentration

RPD – relative percent difference

Normalized absolute differences (NAD) Calculation:

$$\text{NAD} = \frac{\bullet[\text{Sample}] - [\text{Blank}]\bullet}{(\text{TPU}_{\text{sample}}^2 + \text{TPU}_{\text{blank}}^2)^{1/2}}$$

Where: [Sample] = sample concentration

[Blank] = blank concentration

Duplicate error ratio (DER) Calculation:

$$\text{DER} = \frac{\bullet([\text{Sample}] - [\text{Duplicate}])\bullet}{([\text{TPU}_{\text{Sample}}]^2 + [\text{TPU}_{\text{Duplicate}}]^2)^{1/2}}$$

Where: [Sample] = sample concentration

[Duplicate] = duplicate concentration

TABLE 2-1

REQUIREMENTS FOR SAMPLE CONTAINERS, VOLUMES, PRESERVATION, AND HOLDING TIMES

Parameter(s)	Analytical Method	Sample Container	Preservation	Holding Time
Soil Samples For Metals				
ICPMS Metals	6020A	4-ounce wide-mouth glass jar with Teflon™-lined lid	Cool to d 6 °C for mercury (other metals not required to be cooled)	6 months
Mercury	7471A			28 days
Soil Samples for Radiological				
Ra-226 and K-40 Th-232	901.1M	16-ounce wide-mouth glass jar with Teflon™-lined lid	None	None
Air Samples for Radon				
Rn-222	115	charcoal canister in sealed plastic bag	None	None
Equipment Rinsate Blank Samples (Water)				
ICPMS Metals	6020A	1 x 250 mL poly (unfiltered)	pH < 2 with nitric acid	6 months
Mercury	7470A	1 x 250 mL poly (unfiltered)	pH < 2 with nitric acid; cool to d 6 °C	28 days
Ra-226	903.1	1 L poly (filtered)	pH < 2 with nitric acid	None
K-40	901.1	1 L poly (filtered)	pH < 2 with nitric acid	None
Th-232				

ICPMS - inductively coupled plasma/mass spectrometer

L - liter

mL - milliliters

°C - degrees Celsius

ATTACHMENTS

Attachment A
EDD Specifications

MWH ELECTRONIC DATA DELIVERABLE REQUIREMENTS
(rev. March 2011)

Field Name	Format	Description	Constraints	Comments
AFIID	C5 (Valid Value List)	USAF Installation Code	Required	
LABSAMPID	C20	Lab Sample Identifier	Required	
LOCID	C15	Location Name	Required	
MATRIX	C2 (Valid Value List)	Sampling Matrix	Required	
SBD	N8,2	Sample Beginning Depth	Required	
SED	N8,2	Sample Ending Depth	Required	
LOGDATE	D11 (DD-MMM-YYYY)	Sample Date	Required	
LOGTIME	C4 (HHMM)	Sample Time	Required	
LABCODE	C4 (Valid Value List)	USAF Lab Identifier	Required	
SACODE	C2 (Valid Value List)	Sample Type	Required	
SAMPNO	N2,0	Sample Number	Required	
ANMCODE	C7 (Valid Value List)	Analytical Method Code	Required	
EXMCODE	C7 (Valid Value List)	Extraction Method Code	Required	
EXTDATE	D11 (DD-MMM-YYYY)	Extraction Date	Conditional	
EXTTIME	C4 (HHMM)	Extraction Time	Conditional	
ANADATE	D11 (DD-MMM-YYYY)	Analysis Date	Required	
ANATIME	C4 (HHMM)	Analysis Time	Required	
LABLOTCTL	C10	Laboratory Preparation Batch ID	Required	
PARLABEL	C12 (Valid Value List)	Parameter Label	Required	
PARVAL	N16,6	Measured Concentration	Required	
UNITS	C10 (Valid Value List)	Units of Measure	Required	
PARVQ	C2 (Valid Value List)	Parameter Value Qualifier	Required	
BASIS	C1 (Valid Value List)	Wet or Dry Basis (for soil data)	Required	
DILUTION	N16,6	Dilution Factor	Required	
LOGCODE	C4 (Valid Value List)	Logging Company Code	Required	Should equal "MWSL"
SMCODE	C2 (Valid Value List)	Sampling Method Code	Required	
FLDSAMPID	C30	Field Sample ID	Required	
COCID	C12	Chain of Custody ID	Optional	
COOLER	C10	Field Cooler ID	Optional	
ABLOT	C8 (DDMMYYNN)	Ambient Blank Lot ID	Optional	
EBLOT	C8 (DDMMYYNN)	Equipment Blank Lot ID	Optional	
TBLOT	C8 (DDMMYYNN)	Trip Blank Lot ID	Optional	
PARUN	N12,4	Uncertainty	Conditional	
PRECISION	N1	Primary Value Precision	Required	
EXPECTED	N16,6	Expected Value (for spiked samples)	Conditional	
EVPREC	N1	Expected Value Precision	Conditional	
MDL	N16,6	Method Detection Limit	Conditional	
RL	N16,6	Reporting Limit	Conditional	
LCHMETH	C7 (Valid Value List)	Leachate Method	Required	
RUN_NUMBER	N2	Run Number	Required	
LCHDATE	D11 (DD-MMM-YYYY)	Leachate Date	Conditional	
LCHTIME	C4 (HHMM)	Leachate Time	Conditional	
LCHLOT	C10	Leachate Lot	Conditional	
ANALOT	C10	Analytical Lot	Required	
PRCCODE	C3 (Valid Value List)	Analyte Type	Required	
CALREFID	C10	Calibration Reference	Optional	
VQ_IC	C2 (Valid Value List)	PARVQ of first Column	Optional	
VAL_IC	N16,6	Result of first Column	Optional	
FCVALPREC	N1	Precision of first Column	Optional	
VQ_CONFIRM	C2 (Valid Value List)	PARVQ of Confirmation Column	Optional	
VAL_CONFIRM	N16,6	Result of Confirmation Column	Optional	
CNFVALPREC	N1	Precision of Confirmation Column	Optional	
LAB_DQT	C5 (Valid Value List)	Type of Data Qualifier System	Optional	To be provided by MWH project chemist
LAB_QC_FLAG	C6 (Valid Value List)	Laboratory Flags	Conditional	Previously referred to as QAPP_FLAG
REC_DATE	D11 (DD-MMM-YYYY)	Date Sample Received in Lab	Required	
COMPNAME	C50	Compound Name	Required	Not an ERPIMS field

MWH ELECTRONIC DATA DELIVERABLE REQUIREMENTS (rev. March 2011)

Field Name	Format	Description	Constraints	Comments
CASNUMBER	C10	Chemical Abstract Service No.	Optional	Not an ERPIMS field
SPIKE_ADDED	N16,6	Concentration Spiked	Conditional	
PRIME_FLAG	C6	Validation Qualifiers	Leave Null	Previously referred to as EPA_FLAGS
LOWER_ACCURACY	N14,2	Minimum Precision Control Limit	Conditional	Previously referred to as LOW_LIMIT
UPPER_ACCURACY	N14,2	Maximum Precision Control Limit	Conditional	Previously referred to as HIGH_LIMIT
UPPER_RPD	N14,2	Maximum RPD control limit	Conditional	Previously referred to as RPD
PERCENT_RECOVERY	N14,2	Percent Recovery	Conditional	New field requirement

Notes:

An Excel file is preferred, however, a single delimited text file (.csv) is acceptable. If a csv file is used the delimiters may be commas with quote text qualifiers ("VAL1","VAL2") or tabs.

It is required that all fields be provided in the order listed above, a place-holder must be provided for any null entries.

The latest ERPIMS DLH (Data Loading Handbook) version must be used to obtain valid values.

The format column lists the data type ([N]umber, [C]haracter, [D]ate) followed by the number of allowed characters. For number data types the number of decimal places is indicated by the number following the comma. Additional format constraints are listed within parenthesis.

The PARVAL field is the actual concentration (not percent recovery) unless the PRCCODE = STD (surrogate results).

The LOGDATE and LOGTIME fields are required, for LABQC samples use the earlier of the EXMDATE/TIME or ANMDATE/TIME.

Conditional Constraints:

FLDSAMPID should repeat the LABSAMPID for LABQC samples.

EXTDATE, EXTTIME are required unless the EXMCODE = "NONE"

LCHDATE, LCHTIME and LCHLOT are required unless the LCHMETH = "NONE"

PERCENT RECOVERY is required whenever the SACODE = MS,SD,BS, or BD. It should not be populated when the PRCCODE = STD (surrogates).

PARUN is required only when PRCCODE = RN (Radionuclides); it should not be populated in any other instance.

MDL and RL are required for all results unless the PRCCODE = MI,PM,BAC or STD. Do not populate MDL and RL for TICs (PARVQ = TI). When QSM is used RL = LOQ and MDL = LOD.

EXPECTED is required when SACODE <> 'N'. EXPECTED is required for records with a PRCCODE = STD regardless of SACODE. EXPECTED is reported in the same units as PARVAL.

EVPREC should be populated each time an EXPECTED value is required.

LAB_QC_FLAG is required when a flag is needed.

SPIKE ADDED, LOWER AND UPPER ACCURACY are required whenever the SACODE = MS,SD,BS, or BD. It is also required whenever the PRCCODE = STD.

UPPER_RPD is required for all records with a SACODE of LR,SD,BD,FR,or FD unless the PRCCODE = STD.

Attachment B
Soil Preparation SOP

1.0 Introduction

P4 Production (P4) will be collecting and analyzing soil samples for target elements to characterize the mine dumps at its Southeast Idaho mine sites. This standard operating procedure (SOP) specifies the process and requirements for preparing soil samples for analysis. The laboratory will use the procedures presented herein for the sample preparation and analysis of soil samples for the analytes listed in Section 2.0.

2.0 Target Analytes

A total of 19 analytes will be tested in the prepared soil samples. Antimony, arsenic, boron, cadmium, chromium, cobalt, copper, manganese, molybdenum, nickel, selenium, silver, thallium, uranium, vanadium, and zinc will be analyzed by inductively coupled plasma atomic emission spectrometry (ICP-AES)/mass spectrometry (MS) or ICPMS; mercury by manual cold vapor atomic absorption technique (CVAA); and radium-226, potassium-40, and thorium-232 will be analyzed by gamma spectroscopy.

Table 2-1: Target Analytes

Analytical Method	Analyte
6020A – ICPMS	Antimony
	Arsenic
	Boron
	Cadmium
	Chromium
	Cobalt
	Copper
	Manganese
	Molybdenum
	Nickel
	Selenium
	Silver
	Thallium
	Uranium
	Vanadium
	Zinc
7471A – CVAA	Mercury
901.1M – Gamma Spectroscopy	Radium-226
	Potassium-40
	Thorium-232

3.0 Methods for Preparation and Analysis of Soil Samples

Preparation of a project soil sample consists of the procedures used to obtain a dry aliquot of homogenous material. Separate containers will be supplied for metals and radionuclide samples. The radionuclide sample requires a 25-day incubation period. All other preparation procedures apply to both the metals and radionuclide samples, with the exception that the soil sample for metals' analyses will not be ground.

The laboratory will use the following procedures to dry, sieve (radionuclides only), sub-sample, and digest (metals only; not radionuclides) soil samples.

3.1 Drying

The laboratory will determine the initial percent solids on each soil sample as received (the initial percent solids will be reported only, and not used to correct the results). Each soil sample will be air dried at room temperature to a constant weight, or to a final percent solids level of at least 99 percent.

3.2 Sieving

Crush the dry soil using a gloved hand and sieve the material through a No. 10 (2mm) sieve. Discard the sticks, stones, or extraneous matter not passing the sieve.

3.3 Digestion Procedure for ICPMS and CVAA

The analysts will mix the sieved sample and take a representative sub-sample of at least 1.0 g, weighed to the nearest 0.01 g, for each of the following digestion procedures:

- Perform one acid digestion using SW-846 method 3050A to prepare samples for analysis by ICP/MS method 6020A (USEPA, 2007).
- Perform an aqua regia digestion following SW-846 method 3051A to prepare samples for analysis by CVAA method 7471A (USEPA, 2007).

Each prepared sample so processed, for the validation study or investigation, will be analyzed for the metals listed in Table 2-1 using SW-846 methods 6020A and 7471A and consistent with the criteria specified in the project QAPP.

3.4 Procedure for Radionuclides

No additional preparation is required for soil sample analysis for radionuclide testing.

4.0 References

Health Canada, 1999. Method T – 306, Determination of Ni, Pb, Cd, Cr, As, Se and Hg in Whole Tobacco, December.

United States Environmental Protection Agency (USEPA), 2007. Test Methods for Evaluating Solid Wastes: Physical/Chemical Methods, SW- 846 -Third Edition, Final Updates I, II, IIA, IIB, III, IIIA, IIIB, and IV. February.

Attachment C
Data Validation Report Templates

Report# #####

**Laboratory Data Consultants, Inc.
Data Validation Report**

Project/Site Name: Southeast Idaho Mine Sites

Report Date: November 1, 2008

Matrix: Water

Parameters: Mercury by CVAA EPA Method 7470A

Validation Level: EPA Level IV

Laboratory: Microbac

Sample Delivery Group (SDG): 44433

Sample Identification	Collection Date	Laboratory Identification
TSB-GJ-08-10	5/12/08	44433-01
TSB-GJ-08-20	5/12/08	44433-02
TSB-GJ-08-30	5/12/08	44433-03
TSB-GJ-08-40	5/12/08	44433-04
TSB-GJ-08-10MS	5/12/08	44433-05

Introduction

This data review covers 6 water samples listed on the cover sheet including dilutions and reanalysis as applicable. The analysis was performed per the EPA Method noted below:

- Method 7470A: Mercury.

This review follows the specific guidance in the QAPP Addendum (MWH 2008) to the project SAP (April 2004) using the intent of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (October 2004) as applicable to the method stated above.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Raw data were reviewed for a minimum of 10% of the Sample Delivery Groups (SDGs) or laboratory data package deliverables associated with this sampling event as specified in the QAPP Addendum. This package includes raw data review.

The following are definitions of the data qualifiers:

- | | |
|----|---|
| U | The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit. |
| J | The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample. |
| J+ | The result is an estimated quantity, but the result may be biased high. |
| J- | The result is an estimated quantity, but the result may be biased low. |
| R | The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample. |
| UJ | The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise. |

The following are not data qualifiers but are provide for the purpose of evaluating the laboratory's performance:

- | | |
|---|---|
| A | Indicates the finding is based upon technical validation criteria. |
| P | Indicates the finding is related to a protocol/contractual deviation. |

The following "Reason Codes" will be applied as applicable to the validated data:

- 1 Holding Time
- 2 Sample Preservation (including receipt temperature)
- 3 Sample Custody
- 4 Missing Deliverable
- 5 ICPMS Tune
- 6 Initial Calibration
- 7 Initial Calibration Verification
- 8 Continuing Calibration Verification
- 9 Low-Level Calibration Check Sample
- 10 Calibration Blank
- 11 Laboratory or Preparation Blank
- 12 ICPMS or ICP Interference Check Standard
- 13 Laboratory Control Sample or Laboratory Control Sample Duplicate Recovery
- 14 Laboratory Control Sample Precision
- 15 Laboratory Duplicate Precision
- 16 Matrix Spike or Matrix Spike Duplicate Recovery
- 17 Matrix Spike/Matrix Spike Duplicate Precision
- 18 ICPMS or ICP Serial Dilution
- 19 ICPMS Internal Standard
- 20 Field Replicate Precision
- 21 Equipment Rinsate Blank
- 22 Linear Range Exceeded
- 23 Other reason

I(a). Deliverables and Chain-of-Custody Documentation

All deliverables were present and complete including the Case Narrative with full explanation of corrective actions and all package deliverables defined in the project SAP.

The chain-of-custodies were complete for sample identification, matrix, methods, preservation, dates and times of collection, dates and times of relinquishment and receipt. Any corrections preformed properly (i.e., crossed-out with a single line; correction visible, neat, and clear; and with initials of individual making correction).

I(b). Preservation and Holding Times

All technical holding time requirements (28 days) were met.

All samples were received intact with proper preservation (pH < 2 for water).

II. Calibration

An initial calibration was performed each day of analysis. The blank plus 4 standard curve produced a correlation coefficient of > 0.995. The frequency and analysis criteria (80-120%) of the initial calibration verification (ICV) and continuing calibration verification (CCV) were met.

The low-level initial calibration verification (LLICV) and low-level continuing calibration verifications (LLCCVs) standard frequency and limits (70-130%) were met.

III. Blanks

Method blanks were reviewed for each matrix as applicable. No contaminant concentrations were found in the initial, continuing and preparation blanks with the following exceptions:

Method Blank ID	Analyte	Maximum Concentration	Associated Samples
ICB/CCB	Mercury	0.1 ug/L	All samples in SDG 44433

Sample concentrations were compared to concentrations detected in the ICB/CCB/PBs per the National Functional Guidelines (and associated field results between the MDL and RL were flagged as U at the detected values). No samples were qualified with the following exceptions:

Sample	Analyte	Reported Concentration	Modified Final Concentration
TSB-GJ-08-10	Mercury	0.2 ug/L	0.2U ug/L

Sample "RINSATE 1" (from SDG 444120137) was identified as a rinsate. No metal contaminants were found in this blank. Association of results in rinsates samples to field samples and impact of concentrations detected in rinsate samples to field sample results are not addressed in this report, but will be assessed as part of a separate data usability assessment.

IV. Laboratory Control Sample (LCS)

Spike amounts were reviewed and concentrations are noted to be at or near the mid-point of the calibration. Percent recoveries (%R) were within 80-120% with the following exceptions:

Spike ID (Associated Samples)	Analyte	LCS (%R) (Limits)	Flag	A or P
TSB-GJ-08-10LCS (All samples in SDG 44433)	Mercury	125.2 (80-120) -	J+ (all detects) UJ (all non-detects)	A

All samples in the batch for the analytes having %Rs outside control limits were qualified as summarized above.

V. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. Relative percent differences (RPDs) were within the acceptance criteria of $\leq 20\%$ for water or $\leq 35\%$ for soil. For low level results, $<5 \times \text{RL}$, a difference of $\pm 1 \times \text{RL}$ is allowed for water and $\pm 2 \times \text{RL}$ for soils.

VI. Spike Sample Analysis

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Spike amounts were reviewed and concentrations are noted to be at or near the mid-point of the calibration. Percent recoveries (%R) were within 75-125% and relative percent differences (RPD) were within 20% limits with the following exceptions (qualification applies only if the spike value times 4 > sample result):

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
TSB-GJ-08-10MS/MSD (All samples in SDG 44433)	Mercury	140.1 (75-125)	135.4 (75-125)	-	J+ (all detects)	A

VII. Field Replicates

Field replicate samples were collected in triplicate. Control limit(s) were not established in the SAP since the average of the replicate samples is used as the final value for the field

location. Results of field replicate samples or other project samples were not qualified based on the precision of field replicate samples.

VIII(a). Sample Result Verification

All sample result verifications were acceptable.

VIII(b). Overall Assessment of Data

Data flags are summarized at the end of this report if data has been qualified.

Metals - Data Qualification Summary - SDG 44433

SDG	Sample	Analyte	Flag	A or P	Reason
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Mercury	J+ (all detects)	A	Matrix spike/Matrix spike duplicates (%R)
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Mercury	J+ (all detects)	A	Laboratory control sample (%R)

Metals - Laboratory Blank Data Qualification Summary - SDG 44433

SDG	Sample	Analyte	Modified Final Concentration	A or P
44433	TSB-GJ-08-10	Mercury	0.2U ug/L	A

Report# #####

**Laboratory Data Consultants, Inc.
Data Validation Report**

Project/Site Name: Southeast Idaho Mine Sites

Report Date: November 1, 2008

Matrix: Water

Parameters: Metals by ICPMS SW-846 Method 6020A

Validation Level: EPA Level IV

Laboratory: Microbac

Sample Delivery Group (SDG): 44433

Sample Identification	Collection Date	Laboratory Identification
TSB-GJ-08-10	9/15/08	44433-01
TSB-GJ-08-20	9/15/08	44433-02
TSB-GJ-08-30	9/15/08	44433-03
TSB-GJ-08-40	9/15/08	44433-04
TSB-GJ-08-10MS	9/15/08	44433-05
TSB-GJ-08-10MSD	9/15/08	44433-06

Introduction

This data review covers 6 water samples listed on the cover sheet including dilutions and reanalysis as applicable. The analysis was performed per the EPA SW 846 Method noted below:

- Method 6020A ICPMS: Aluminum, Antimony, Arsenic, Barium, Beryllium, Boron, Cadmium, Calcium, Chromium, Cobalt, Copper, Iron, Lead, Lithium, Magnesium, Manganese, Molybdenum, Nickel, Niobium, Palladium, Phosphorus, Platinum, Potassium, Selenium, Silicon, Silver, Sodium, Strontium, Sulfur, Thallium, Tin, Titanium, Tungsten, Uranium, Vanadium, and Zinc, and Zirconium.

This review follows the specific guidance in the QAPP Addendum (MWH 2008) to the project SAP (April 2004) using the intent of the USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (October 2004) as applicable to the method stated above.

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Raw data were reviewed for a minimum of 10% of the Sample Delivery Groups (SDGs) or laboratory data package deliverables associated with this sampling event as specified in the QAPP Addendum. This package includes raw data review.

The following are definitions of the data qualifiers:

- | | |
|----|---|
| U | The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit. |
| J | The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample. |
| J+ | The result is an estimated quantity, but the result may be biased high. |
| J- | The result is an estimated quantity, but the result may be biased low. |
| R | The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample. |
| UU | The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise. |

The following are not data qualifiers but are provide for the purpose of evaluating the laboratory's performance:

A Indicates the finding is based upon technical validation criteria.

P Indicates the finding is related to a protocol/contractual deviation.

The following "Reason Codes" will be applied as applicable to the validated data:

- 1 Holding Time
- 2 Sample Preservation (including receipt temperature)
- 3 Sample Custody
- 4 Missing Deliverable
- 5 ICPMS Tune
- 6 Initial Calibration
- 7 Initial Calibration Verification
- 8 Continuing Calibration Verification
- 9 Low-Level Calibration Check Sample
- 10 Calibration Blank
- 11 Laboratory or Preparation Blank
- 12 ICPMS or ICP Interference Check Standard
- 13 Laboratory Control Sample or Laboratory Control Sample Duplicate Recovery
- 14 Laboratory Control Sample Precision
- 15 Laboratory Duplicate Precision
- 16 Matrix Spike or Matrix Spike Duplicate Recovery
- 17 Matrix Spike/Matrix Spike Duplicate Precision
- 18 ICPMS or ICP Serial Dilution
- 19 ICPMS Internal Standard
- 20 Field Replicate Precision
- 21 Equipment Rinsate Blank
- 22 Linear Range Exceeded
- 23 Other reason

I(a). Deliverables and Chain-of-Custody Documentation

All deliverables were present and complete including the Case Narrative with full explanation of corrective actions and all package deliverables defined in the project SAP.

The chain-of-custodies were complete for sample identification, matrix, methods, preservation, dates and times of collection, dates and times of relinquishment and receipt. Any corrections preformed properly (i.e., crossed-out with a single line; correction visible, neat, and clear; and with initials of individual making correction).

I(b). Preservation and Holding Times

All technical holding time requirements were met: 6 months for water and soil (note NIST soil standard reference samples are valid for up to 3 years).

All samples were received intact with proper preservation (pH < 2 for water).

II. ICP-MS Tune Analysis

ICP MS Tuning was performed by the laboratory. All isotopes in the tuning solution mass resolution were within 0.1 amu.

The percent relative standard deviations (%RSD) of all isotopes in the tuning solution were less than or equal to 5.0%.

III. Calibration

An initial calibration was performed each day of analysis. The frequency and analysis criteria (90-110%) of the initial calibration verification (ICV) and continuing calibration verification (CCV) were met.

The low-level initial calibration verification (LLICV) and low-level continuing calibration verifications (LLCCVs) standard frequency and limits (70-130%) were met. Limit for cobalt, manganese and zinc are 50 -150%. Only undetected data, or values < 2 x RL are qualified or impacted.

IV. Blanks

Method blanks were reviewed for each matrix as applicable. No contaminant concentrations were found in the initial, continuing and preparation blanks with the following exceptions:

Method Blank ID	Analyte	Maximum Concentration	Associated Samples
ICB/CCB	Antimony Thallium Tungsten	1.3 ug/L 1.1 ug/L 1.4 ug/L	All samples in SDG 44433

Method Blank ID	Analyte	Maximum Concentration	Associated Samples
	Vanadium Lithium Mercury	2.7 ug/L 8.0 ug/L 0.1 ug/L	

Sample concentrations were compared to concentrations detected in the ICB/CCB/PBs per the National Functional Guidelines (and associated field results between the MDL and RL were flagged as U at the detected values). No samples were qualified with the following exceptions:

Sample	Analyte	Reported Concentration	Modified Final Concentration
TSB-GJ-08-10	Mercury	0.2 ug/L	0.2U ug/L
TSB-GJ-08-20	Thallium Tungsten	0.40 ug/L 0.70 ug/L	0.40U ug/L 0.70U ug/L
TSB-GJ-08-30	Lithium	10.0 ug/L	10.0U ug/L

Sample "RINSATE 1" (from SDG 444120137) was identified as a rinsate. No metal contaminants were found in this blank with the following exceptions:

Rinsate ID	Sampling Date	Analyte	Concentration	Associated Samples
RINSATE 1	6/11/08	Calcium Iron Magnesium Manganese Silicon Sodium Strontium	131 ug/L 154 ug/L 17.9 ug/L 0.84 ug/L 38.6 ug/L 39.2 ug/L 1.5 ug/L	All samples in SDG 44433

Sample concentrations were compared to concentrations detected in the field blanks. No samples were qualified.

V. ICP Interference Check Sample (ICS) Analysis

The frequency of analysis was met.

ICP interference check samples were reviewed for each analyte as applicable. Percent recovery (%R) of the ICSAB were within the QC limits of 80-120%.

VI. Laboratory Control Sample (LCS)

Laboratory control samples were reviewed for each matrix as applicable. Spike amounts were reviewed and concentrations are noted to be at or near the mid-point of the calibration. Percent recoveries (%R) were within 80-120% with the following exceptions:

Spike ID (Associated Samples)	Analyte	LCS (%R) (Limits)	Flag	A or P
TSB-GJ-08-10LCS (All samples in SDG 44433)	Antimony Copper Silicon Vanadium Lithium Nickel Tungsten Zinc	55.2 (80-120) 72.5 (80-120) 65.4 (80-120) 68.4 (80-120) - - - -	J- (all detects) UJ (all non-detects)	A

All samples in the batch for the analytes having %Rs outside control limits were qualified as summarized above.

VII. Duplicate Sample Analysis

Duplicate (DUP) sample analyses were reviewed for each matrix as applicable. Relative percent differences (RPDs) were within the acceptance criteria of $\leq 20\%$ for water or $\leq 35\%$ for soil. For low level results, $<5 \times \text{RL}$, a difference of $\pm 1 \times \text{RL}$ is allowed for water and $\pm 2 \times \text{RL}$ for soils.

VIII. Spike Sample Analysis

Matrix spike (MS) and matrix spike duplicate (MSD) samples were reviewed for each matrix as applicable. Spike amounts were reviewed and concentrations are noted to be at or near the mid-point of the calibration. Percent recoveries (%R) were within 75-125% and relative percent differences (RPD) were within 20% limits with the following exceptions (qualification applies only if the spike value $\times 4 >$ sample result):

Spike ID (Associated Samples)	Analyte	MS (%R) (Limits)	MSD (%R) (Limits)	RPD (Limits)	Flag	A or P
TSB-GJ-08-10MS/MSD (All samples in SDG 44433)	Sulfur Phosphorus	140.1 (75-125) 134.8 (75-125)	135.4 (75-125) -	- -	J+ (all detects) J+ (all detects)	A
TSB-GJ-08-10MS/MSD (All samples in SDG 44433)	Antimony Copper Silicon Vanadium Lithium Nickel Tungsten Zinc	55.2 (75-125) 72.5 (75-125) 65.4 (75-125) 68.4 (75-125) - - - -	39.4 (75-125) 60.9 (75-125) 44.6 (75-125) 56.0 (75-125) 69.8 (75-125) 71.1 (75-125) 60.6 (75-125) 62.2 (75-125)	- - - - - - - -	J- (all detects) UJ (all non-detects)	A
TSB-GJ-08-10MS/MSD (All samples in SDG 44433)	Niobium	40.6 (75-125)	29.7 (75-125)	-	J- (all detects) R (all non-detects)	A

Aluminum, calcium, iron, magnesium, manganese, strontium, and titanium results were outside the QC limits; results were not qualified since the original sample (TSB-GJ-08-10) was greater than 4X the spike amount.

IX. ICP Serial Dilution

ICP serial dilution analysis was performed by the laboratory. The analysis criteria of $\pm 10\%$ difference for values greater than 50 times the lower limit of quantitation (i.e., the reporting limits [RLs]) were met, with the following exceptions:

Sodium and Uranium results were outside the QC limits; data were not qualified since the concentration was less than 50 times the RLs.

X. ICP-MS Internal Standards

All internal standard percent recoveries (%R) were within 70-130% or a 2x dilution was run with acceptable recoveries with the following exceptions:

Sample	Internal Standard	%R (Limits)	Analyte	Flag	A or P
TSB-GJ-08-20	Scandium-45	127.557 (70-130)	Silicon Strontium	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A
TSB-GJ-08-30	Scandium-45	129.653 (70-130)	Silicon Strontium	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A

XI. Field Replicates

Field replicate samples were collected in triplicate. Control limit(s) were not established in the SAP since the average of the replicate samples is used as the final value for the field location. Results of field replicate samples or other project samples were not qualified based on the precision of field replicate samples.

XII(a). Sample Result Verification

All sample result verifications were acceptable.

XII(b). Overall Assessment of Data

Data flags are summarized at the end of this report if data has been qualified.

Metals - Data Qualification Summary - SDG 44433

SDG	Sample	Analyte	Flag	A or P	Reason
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Sulfur Phosphorus	J+ (all detects) J+ (all detects)	A	Matrix spike/Matrix spike duplicates (%R)

SDG	Sample	Analyte	Flag	A or P	Reason
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Antimony Copper Silicon Vanadium Lithium Nickel Tungsten Zinc	J- (all detects) UJ (all non-detects)	A	Matrix spike/Matrix spike duplicates (%R)
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Niobium	J- (all detects) R (all non-detects)	A	Matrix spike/Matrix spike duplicates (%R)
44433	TSB-GJ-08-20 TSB-GJ-08-30	Silicon Strontium	J (all detects) UJ (all non-detects) J (all detects) UJ (all non-detects)	A	Internal standards (%R)
44433	TSB-GJ-08-10 TSB-GJ-08-20 TSB-GJ-08-30 TSB-GJ-08-40	Iron	J (all detects)	A	ICP serial dilution (%D)

Metals - Laboratory Blank Data Qualification Summary - SDG 44433

SDG	Sample	Analyte	Modified Final Concentration	A or P
44433	TSB-GJ-08-10	Mercury	0.2U ug/L	A
44433	TSB-GJ-08-20	Thallium Tungsten	0.40U ug/L 0.70U ug/L	A
44433	TSB-GJ-08-30	Lithium	10.0U ug/L	A

Report# #####

Data Validation Company Name
Data Validation Report

Project/Site Name: Southeast Idaho Mine Sites

Report Date: August 2, 2011

Matrix: Soil Samples (and One Water Field QC Sample)

Parameters: Radium-226 and Potassium-40 by Method 901.1
Modified (soil)

Validation Level: Stage 4

Laboratory: Laboratory Name

Sample Delivery Group (SDG): L55555

Field Sample Identification	Date Collected	Laboratory Sample Identification
1105-MWD085-04-SS	5/16/2011	L55555-01
1105-MWD085-05-SS	5/16/2011	L55555-02
1105-MWD085-06-SS	5/16/2011	L55555-03
1105-MWD085-07-SS-1	5/16/2011	L55555-04
1105-MWD085-07-SS-2	5/16/2011	L55555-05
1105-MWD085-08-SS	5/16/2011	L55555-06
1105-ER-SO-01	5/16/2011	L55555-07

Introduction

This data review covers 6 soil samples (5 primary and 1 field duplicate) and one field blank sample listed on the cover sheet including dilutions and reanalysis as applicable. The analysis was performed per the EPA Method noted below:

- Method 901.1M: Radium-226 and Potassium-40 by Gamma Spectroscopy

This review follows the specific guidance in the *Quality Assurance Project Plan, Appendix B of the Radiological and Background Investigation Sampling and Analysis Plan* (MWH, 2011) using the intent of the USEPA *Contract Laboratory Program National Functional Guidelines for Inorganic Data Review* (October 2004) as applicable to the method stated above; U.S. Department of Energy *Evaluation of Radiochemical Data Usability*, es/er/ms-5 (April 1997); and U.S. Department of Energy *Environmental Measurements Laboratory, Health and Safety Laboratory (HASL)-300 Manual*, Section 4.5.2.3 for Ga-01-R: high resolution germanium detector gamma ray spectrometry (28th Edition; February 1997).

A qualification summary table is provided at the end of this report if data has been qualified. Flags are classified as P (protocol) or A (advisory) to indicate whether the flag is due to a laboratory deviation from a specified protocol or is of technical advisory nature.

Raw data were reviewed for a minimum of 10% of the Sample Delivery Groups (SDGs) or laboratory data package deliverables associated with this sampling event as specified in the QAPP Addendum. This package includes raw data review.

The following are definitions of the data qualifiers:

- | | |
|----|---|
| U | The analyte was analyzed for, but was not detected above the level of the reported sample quantitation limit. |
| J | The result is an estimated quantity. The associated numerical value is the approximated concentration of the analyte in the sample. |
| J+ | The result is an estimated quantity, but the result may be biased high. |
| J- | The result is an estimated quantity, but the result may be biased low. |
| R | The result is unusable. The sample result is rejected due to serious deficiencies in meeting quality control criteria. The analyte may or may not be present in the sample. |
| UJ | The analyte was analyzed for, but was not detected. The reported quantitation limit is approximate and may be inaccurate or imprecise. |

The following are not data qualifiers but are provide for the purpose of evaluating the laboratory's performance:

- | | |
|---|--|
| A | Indicates the finding is based upon technical validation criteria. |
|---|--|

P Indicates the finding is related to a protocol/contractual deviation.

The following "Reason Codes" will be applied as applicable to the validated data:

- 1 Holding Time
- 2 Sample Preservation (including receipt temperature)
- 3 Sample Custody
- 4 Missing Deliverable
- 5 - not applicable to this method -
- 6 Initial Calibration
- 7 (not applicable to this method)
- 8 Continuing Calibration Verification
- 9 - not applicable to this method -
- 10 - not applicable to this method -
- 11 Laboratory or Preparation Blank
- 12 - not applicable to this method -
- 13 Laboratory Control Sample or Laboratory Control Sample Duplicate Recovery
- 14 Laboratory Control Sample Precision
- 15 Laboratory Duplicate Precision
- 16 Matrix Spike or Matrix Spike Duplicate Recovery
- 17 Matrix Spike/Matrix Spike Duplicate Precision
- 18 - not applicable to this method -
- 19 - not applicable to this method -
- 20 Field Replicate Precision
- 21 Equipment Rinsate Blank
- 22 Linear Range Exceeded
- 23 Other reason
- 24 Result is less than the MDC
- 25 Result is less than two times the error

I. Chain-of-Custody Procedure, Sample Preservation, and Holding Time

- ☒ Signatures on chain(s) and all samples accounted for
- ☒ Ra-226 and K-40 in soil: collected in HDPE (polyethylene) unpreserved containers; minimum 25-day incubation period (there is no holding time requirement)

A total of six soil samples (5 primary and 1 field duplicate) and one field blank sample were collected on May 16, 2011 in proper containers. Samples were shipped and arrived at the laboratory on May 17, 2011. Sample chain-of-custody and laboratory receipt documentation were intact. The samples were analyzed after the required minimum 25-day incubation period specified in the QAPP, and specifically on June 14, 2011, 28 days from collection to analysis.

II. Instrument Calibration

- ☒ Confirm dates of calibration, detectors IDs, geometry, counting times, number of counts for each standard, measured activity for all standards, identity and true value of all standards
- ☒ Confirm matrix used in geometry standard
- ☒ Evidence of decay correction of standard prior to calculation of efficiencies, as appropriate
- ☒ Calibration points including efficiencies for each detector
- ☒ Background checks performed at the time of initial calibration
- ☒ Self absorption curves for each detector, covering an appropriate range of residue masses
- ☒ Certificates for NBS- or NIST-traceable standards
- ☒ Review standard preparation and dilution logs for accuracy

Initial calibration data were within all required criteria.

III. Calibration Verification

- ☒ Tolerance chart or statistical control chart of the appropriate efficiencies and background activities (at least 20 points) with ± 2 sigma error (warning) and ± 3 sigma error (failure) limits
- ☒ Routine (daily, weekly, monthly) background checks for each detector
- ☒ Daily efficiency checks for each detector
- ☒ Evidence of decay correction of standard prior to calculation of efficiencies, as appropriate
- ☒ Confirm detector IDs and geometries used in analysis
- ☒ Check if sample residues are within the range of the self absorption curve

Calibration verification data were within all required criteria.

IV. Target Compound Identification and Quantitation

- ☒ Confirm all samples less than MDC are qualified not detected (U)
- ☒ Less than two times the uncertainty (2 sigma error) were reported by the laboratory as not detected

Sample results that were reported as values less than the MDC were qualified as not detected at the MDC (flagged U). Sample results that were less than two times the error were qualified as not detected at the MDC (flagged U) or qualified as not detected at the reported concentration (flagged U). The following results were qualified:

Field Sample Identification	Laboratory Sample ID	Parameter	Result (pCi/g)	MDC (pCi/g)	2*Error	Data Validation Result	Reason Code
1105-MWD085-04-SS	L55555-01	Ra-226	3.6	2.0	3.8	3.6 UJ	25
1105-MWD085-	L55555-01	K-40	0.24	4.0	2.4	4.0 UJ	24

APPENDIX C

RADIOLOGICAL SITE AND BACKGROUND INVESTIGATION SAP

HEALTH AND SAFETY PLAN ACTIVITY HAZARD ANALYSIS

Tasks	Hazards	Controls	PPE Required
Sampling at Operating Mine Sites (including sites being reclaimed)	<ul style="list-style-type: none"> Cuts and scrapes 	<ul style="list-style-type: none"> Follow procedures of mine operator. Report injuries to buddy or to person designated by mine operator for first aid if necessary. Come to work alert and ready—make sure that general awareness of surroundings is part of job planning and execution. Wear heavy work gloves when handling sharp objects, and point sharp objects toward the ground. 	<p>Minimum: hard-hat, safety glasses, boots, long pants, and cotton shirt; heavy work gloves for handling sharp objects.</p> <p>Additional PPE as specified by the mine operator.</p>
	<ul style="list-style-type: none"> Heat or cold stress 	<ul style="list-style-type: none"> Monitor for heat and cold stress as outlined in the Health and Safety Plan (see Section 7.0). 	
	<ul style="list-style-type: none"> Slips/trips/falls 	<ul style="list-style-type: none"> Maintain general awareness of surroundings. 	
	<ul style="list-style-type: none"> Being struck by heavy equipment or caught between equipment and a stationary object 	<ul style="list-style-type: none"> Receive site-specific hazard training. Be alert to the direction of traffic flow. Maintain eye contact with heavy equipment operators and give them the right-of-way. Never stand between operating vehicles and nearby stationary objects. Ask the mine operator where the blind spots for each piece of equipment are located— DO NOT STAND IN BLIND SPOTS. 	

Tasks	Hazards	Controls	PPE Required
Sampling at Operating Mine Sites (continued)	<ul style="list-style-type: none"> High wall collapse 	<ul style="list-style-type: none"> Receive site-specific hazard training. Perform work under escort of mine employee. Do not stand between high wall and heavy equipment—make sure you have an escape route. Know the mine emergency signals and evacuation procedures. 	
Sampling at Inactive Mine Sites	<ul style="list-style-type: none"> Cuts and scrapes Slips/trips/falls Dislodged rocks 	<ul style="list-style-type: none"> Report injuries to buddy for first aid if necessary. Come to work alert and ready—make sure that general awareness of site surroundings is part of job planning and execution. Wear heavy work gloves when handling sharp objects, and point sharp objects toward the ground. Do not walk at the edge of sharp drop-offs. Maintain special care on scree slopes or while working in other areas with unstable footing. Maintain general awareness of surroundings. Be aware of the possibility of abandoned underground mine portals. Avoid areas below people who may dislodge rocks while working or walking on slopes. Cry “ROCK” after dislodging a rock when other people are below. 	Minimum: hard-hat, boots, long pants, and cotton shirt; heavy work gloves for handling sharp objects.

Tasks	Hazards	Controls	PPE Required
Sampling at Inactive Mine Sites (cont.)	<ul style="list-style-type: none"> Deteriorated roads 	<ul style="list-style-type: none"> Receive site-specific hazard training. Exercise care while traveling by vehicle. 	
	<ul style="list-style-type: none"> High wall collapse or rock-fall 	<ul style="list-style-type: none"> Receive site-specific hazard training. Know signs of instability. Carefully examine the surroundings to determine if entry is safe. Be aware of the most efficient evacuation route. Do not walk on top of high walls. Avoid working downslope of rock slides. 	
	<ul style="list-style-type: none"> Heat or cold stress 	<ul style="list-style-type: none"> Monitor for heat and cold stress as outlined in the Health and Safety Plan (see Section 7.0). 	
Travel in Remote Areas	<ul style="list-style-type: none"> General 	<ul style="list-style-type: none"> Always carry ten essentials for wilderness travel (see Table 2-3). 	Heavy work gloves for handling sharp objects.
	<ul style="list-style-type: none"> Slips/trips/falls 	<ul style="list-style-type: none"> Maintain general awareness of surroundings. 	
	<ul style="list-style-type: none"> Cuts and scrapes 	<ul style="list-style-type: none"> Report injuries to buddy for first aid. Come to work alert and ready—make sure that general awareness of site surroundings is part of job planning and execution. Wear heavy work gloves when handling sharp objects, and point sharp objects toward the ground. 	

Tasks	Hazards	Controls	PPE Required
Travel in Remote Areas (cont.)	<ul style="list-style-type: none"> Safe drinking water 	<ul style="list-style-type: none"> Contact National Forest officials in advance regarding any water quality advisories. Bring sufficient water. Assume that you will need one gallon of drinking water per person per day. 	
	<ul style="list-style-type: none"> Severe weather 	<ul style="list-style-type: none"> Bring proper rain gear and warm clothes. Listen to weather forecasts before entering remote areas. If severe weather is likely, postpone sampling. In case of lightning, avoid high ground and open areas. In the event of rain, monitor for hypothermia. In the event of snow, monitor for frostbite and hypothermia. In the event of a blizzard that reduces visibility, stay put in an emergency shelter. Do not risk disorientation. 	
	<ul style="list-style-type: none"> Getting lost 	<ul style="list-style-type: none"> Provide the Program Manager or designee with itineraries, including travel routes and the expected date and time of return. Check in once per day, if possible, when in remote areas. Always check in with the Program Manager or designee before and after sampling. The Program Manager or designee will contact search and rescue if field personnel do not return or call in by the specified time. Bring emergency shelter. 	

Tasks	Hazards	Controls	PPE Required
Travel in Remote Areas (cont.)		<ul style="list-style-type: none"> If lost, stay put. You are easier to find this way. 	
	<ul style="list-style-type: none"> Heat or cold stress 	<ul style="list-style-type: none"> Monitor for heat or cold stress as outlined in the Health and Safety Plan (see Section 7.0). 	
	<ul style="list-style-type: none"> Muscle strains 	<ul style="list-style-type: none"> Know your limits, and do not overextend yourself. 	
	<ul style="list-style-type: none"> Poisonous plants and animals 	<ul style="list-style-type: none"> Be able to recognize poisonous plants and animals and avoid them. If bitten by a snake or spider, apply cold compresses. Get to a hospital as quickly as possible. Avoid, if possible, and leave the area. Make yourself look large by raising arms and shouting. 	
	<ul style="list-style-type: none"> Wildlife 	<ul style="list-style-type: none"> Slowly back away, without turning your back to the animal. 	
General Work Practices	<ul style="list-style-type: none"> First aid injuries 	<ul style="list-style-type: none"> Report injuries to buddy for first aid. Seek additional medical attention, if necessary. Notify the PSO. 	Minimum: hard-hat, safety glasses, boots, long pants, and cotton shirt.
	<ul style="list-style-type: none"> Slips/trips/falls 	<ul style="list-style-type: none"> Practice good housekeeping, and remove or reduce slip/trip/fall hazards. Maintain general awareness of surroundings. 	Additional: heavy work gloves and hearing protection, as necessary.

Tasks	Hazards	Controls	PPE Required
General Work Practices (cont.)	• Cuts/scrapes	<ul style="list-style-type: none"> • Report injuries to buddy for first aid. • Come to work alert and ready—make sure that general awareness of site surroundings is part of job planning and execution. • Wear heavy work gloves when handling sharp objects and point sharp objects towards the ground. 	
	• Heat or cold stress	• Monitor for heat and cold stress as outlined in the Health and Safety Plan (see Section 7.0).	
	• Muscle strain	• Alternate activities as needed to give muscles rest.	
	• Slips/trips/falls	• Practice good housekeeping to remove or reduce slip/trip/fall hazards.	
	• Hearing loss	• Use hearing protection when operating loud equipment.	
	• Electrocution	• Use GFCI on portable power equipment.	
	• Power equipment	• See manufacturer's instructions for the use of hand and portable power tools.	

APPENDIX D

RADIOLOGICAL SITE AND BACKGROUND INVESTIGATION SAP

DOCUMENT COMMENTS AND RESPONSES

***A/T Comments on P4's Radiological Site and Background
Investigation Sampling and Analysis Plan Draft Final Revision 1,
March 2014***

Transmitted to P4 on May 23, 2014



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 10
IDAHO OPERATIONS OFFICE
950 West Bannock, Suite 900
Boise, Idaho 83702

May 23, 2014

Rachel Roskelley
Sr. Environmental Engineer
Monsanto Company
Soda Springs Operations
1853 Highway 34
Soda Springs, Idaho 83276

**Re: Comments on Radiological Site and Background Investigation Sampling and Analysis Plan
Draft Final Revision 1, prepared for P4 Production, LLC by MWH, March 2014.**

Dear Ms. Roskelley,

The Agencies and Tribes (A/T) have reviewed the above referenced deliverable, submitted pursuant to the Administrative Settlement Agreement and Order on Consent/Consent Order for Performance of Remedial Investigation and Feasibility Study at the Enoch, Henry, and Ballard Mine Sites in Southeastern Idaho (or 2009 AOC). Enclosed you will find compiled comments and direction from the A/T on the subject document. We will be available to discuss and clarify these comments during our next conference call.

Please produce and distribute a final version of the plan. Alternatively, if you wish, you may produce responses to comments or an electronic version for A/T review and approval in advance of producing and distributing hardcopies of the final document. Please contact me if you have questions. I can be reached at 208-378-5763 or electronically at tomten.dave@epa.gov.

Sincerely,

// s //

Dave Tomten
Remedial Project Manager

Enclosure

cc: Cary Faulk, MWH (electronic version only)
Vance Drain, MWH (electronic version only)
Mike Rowe, IDEQ – Pocatello
Sandi Fisher, US FWS - Chubbuck
Kelly Wright, Shoshone Bannock Tribes
Susan Hanson (for the tribes)
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Mary Kaufman, FS – Pocatello

Colleen O'Hara, BLM

Eldine Stevens, BIA (electronic version only)

Bob Blaesing, BIA (electronic version only)

Tim Mosko, CH2MHill (electronic version only)

Charles Allbritton, EPA Records Center (electronic version only)

Don Matheny, EPA R10 QA Office (electronic version only)

A/T comments on P4 Production, LLC Radiological Site and Background Investigation Sampling and Analysis Plan Draft Final Revision 1, prepared for P4 Production by MWH, March 2014.

General Comments

- GC-1. The premise is that data collected at reference areas in Caldwell Canyon and at Blackfoot Bridge would be representative of background at Ballard, Henry, and Enoch Valley mines. Some of the specific comments below note that chemical alteration and weathering of bedrock has been observed from one mine to another and even within the scale of an individual mine. As soil samples will be taken at background sites from areas overlying the Wells Formation in the reference areas, it will be possible to compare these results to background data collected in 2009 on Wells Formation near the sites to give some indication if this theory is correct. However, no additional sampling is planned for Dinwoody Formation. It is recommended P4/Monsanto include sampling of soils overlying the Dinwoody Formation in the background reference areas for further comparison to the historic mines background data to further evaluate representativeness.
- GC-2. One of the more important study questions relates to the comparison of site concentrations of radiological contaminants of surface materials (mostly waste rock) to background soil concentrations. Many of the statements within the Sampling and Analysis Plan (SAP) appear to be geared towards answering the fundamental question of whether or not the removal of ore has had the effect of decreasing site U and Ra-226 concentrations (where waste rock is exposed at the surface) relative to soils in background areas, but it is not clearly stated as the highest level study question to be answered.
- GC-3. Although the immediate objective is characterizing radiological properties surface material materials and soils, it will be necessary to refine ARARs in the forthcoming feasibility study for Ballard. One question to sort out is whether or not the waste rock qualifies as Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). Ultimately the ARARs associated with radioactivity that are carried forward into the ROD may depend on whether the waste rocks are or are not TENORM.
- GC-4. The current sampling plan offers the opportunity to reduce uncertainties associated with previous sampling. The A/T recommends that P4 consider replacing the 5-point composites with a larger number of points (aliquots) per composite in an attempt to be more in-line with more recent sampling guidance (ITRC, 2012). This may reduce data variability and improve representativeness of BTV estimation. For clarification, the A/T expects that the total number of composite samples per geologic formation would remain the same (20 composite samples per formation).

Before deciding to add increments to each composite sample, comparability with previous, 5-point composite samples should be evaluated before adding the extra increments (aliquots). This should not be a concern for “new data” including radiological parameters or background in the Meade Peak, Rex Chert and Cherty Shale Members because samples have not been previously collected, but might be problematic when pooling with the existing Wells and Dinwoody Formation background samples. Include sample processing procedures consistent with current EPA practices (USEPA 2003).

- GC-5. As noted in previous discussions and correspondence, the inclusion of outliers in the computation of the various decision statistics tends to yield inflated values of those decision statistics, which can lead to incorrect decisions. This is especially important when calculating USLs. As EPA notes in USEPA (2013):

“To provide a proper balance between false positives and false negatives, the upper limits described above, especially a 95% USL (USL95) should be used only when the background data set represents a single environmental population without outliers (observations not belonging to background). Inclusion of multiple populations and/or outliers tends to yield elevated values of USLs (and also of UPLs and UTLs) which can result in a high number (and not necessarily high percentage) of undesirable false negatives, especially for data sets of larger sizes (e.g., $n > 30$).”

Therefore, similar to past practice, the A/T will continue to require that the background datasets be rigorously evaluated for the presence of outliers before accepting revisions to final BTVs. In addition, the evaluation of the data set will be necessary confirm or verify the appropriate statistical measure (e.g., 95/95 UTL vs. 95% USL) for the final BTVs.

- GC-5. The sampling plan should be revised to include tables that summarize the number, location, and type of samples collected along with the analytical methods and associated reporting limits relative to risk-based values.
- GC-6. As required under the 2009 AOC, all deliverables are to be submitted as “draft” for Agency review and approval. This document was submitted as “Draft Final Rev01”. Revise to clarify this is an initial draft of the document.
- GC-7. Revise for consistency in use of “Phosphoria Formation” and “Phosphoria formation.”
- GC-8. Note that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario for non-transient media is unlikely and as such, will not be included in the HHRA for those portions of the Sites. The residential risk scenario should be included for surface water and groundwater due to the transient nature of these media. Please revise all relevant portions of this SAP accordingly.
- GC-9. In the Background Section of the current SAP, P4 states that researchers have noted that the Meade Peak Member is enriched in several COPCs compared to their respective averages in world-wide shale and reference Herring and Gauch, 2004 to support this statement. The text goes on to state that it is believed that in undisturbed (pre-mining) areas, the enriched concentrations of COPCs in the Meade Peak Member likely will contribute to an elevated background in soils overlying the Phosphoria Formation and may result in elevated concentrations in soils downslope of formation outcrops. The text does not clarify by whom it is believed that in undisturbed areas the enriched concentrations of COPCs in the Meade Peak.... The text must be revised to clarify that this is a working hypothesis that will be evaluated using data collected under this proposed SAP. In addition, this section does not acknowledge that Herring and Gauch, 2004, also noted substantial differences in COPC “enrichment” associated with weathering and that those undisturbed sections of the Meade Peak Member closest to the surface had noticeably lower concentrations of COCPs compared to undisturbed Meade Peak at depth. Revise to place this observation in the context of the proposed work (i.e., outcrops of the Phosphoria Formation will be weathered

and soils collected from those outcrops most likely will *not* contain the highly “enriched” COPC concentrations as P4 suggests for the rationale to collect additional background soil samples).

Specific Comments

- SC-1. **Section 1.1, Background, page 1-2, 1st paragraph:** The text states that it is believed that in undisturbed areas the enriched concentrations of COPCs in the Meade Peak Member will likely contribute to an elevated background in associated soils. However, Herring and Grauch, 2004, noted that COPC concentrations are greatly reduced due to weathering, so one could reasonably expect such weathering would have occurred over time on the “undisturbed” outcrops of the Meade Peak Member such that those soils may no longer be considered “enriched” in COPC concentrations relative to other naturally-occurring shales in the Western United States. Revise accordingly.
- SC-2. **Section 1.1, Background, page 1-2, 3rd paragraph, last sentence:** The text states “The evaluation of human health risk from uranium series radionuclides in the **various media** [bold emphasis added] at the Sites needs to address both chemical and radiological risk.” Revise to clarify that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario is unlikely and as such, will not be included in the HHRA for those portions of the Sites. Additionally, the only human health radiological risk would be from radon exposure within an enclosure (such as a residence). It is unclear why media other than soils would need to be evaluated for radiological risk for the other portions of the Sites. Clarify as needed.
- SC-3. **Section 1.1, Background, page 1-2, last paragraph:** The text states “Results of the Ballard Mine HHRA show that the chemical and/or radiological risks associated with COPCs that are naturally enriched in the Meade Peak Member exceed acceptable risk or hazard criteria.” The text goes on to state “For example, chemical risk estimates for arsenic exceed the State of Idaho’s acceptable cancer risk criterion of 1×10^{-5} for a hypothetical future resident and a current/future Native American exposed to arsenic in upland soil.” It is important to note that arsenic is not one of the COPCs identified by Herring and Grauch, 2004, as being enriched in the Meade Peak Member. The text goes on to state “In addition, the chemical noncancer hazard estimates for a current/future Native American exposed to arsenic, selenium, total uranium, and several other COPCs in culturally significant plants grown in upland soil, and for a hypothetical future resident exposed to arsenic, selenium, thallium, zinc and several other COPCs in fruits and vegetables grown in upland soils, exceed the State of Idaho and USEPA acceptable hazard quotient (HQ) of 1.” Herring and Grauch, 2004, note that the trace elements most easily removed by weathering include selenium and to a lesser extent, chromium, copper, molybdenum, antimony and zinc. Again, given the current conceptual model for the Sites, one would expect the current COPC concentrations in the overburden waste rock near the surface to represent relatively highly weathered geochemical conditions with reduced COPC concentrations compared to undisturbed Meade Peak Member material at depth. Please revise accordingly.
- SC-4. **Section 1.1, Background, page 1-3, 2nd paragraph, 2nd sentence,.** The text states: “This overestimation of radiogenic human health risks in the Ballard Mine HHRA (MWH,

2013a) are likely due to (1) the sequential decay modeling from total uranium concentrations in soil..." Given that the uranium present is in the form of ores that have not been chemically processed/altereD, the assumption that all uranium daughters are present in a state of equilibrium is a very reasonable one. In fact, disequilibrium would be a condition that would have to be carefully explained if it is being argued that any uranium present is not TENORM. Please explain why an assumption of equilibrium is being considered to be causing overestimation of risks.

- SC-5. **Section 1.1, Background, page 1-3, 2nd complete paragraph, last sentence:** As commented on previously, arsenic is not one of the COPCs noted by Herring and Grauch as elevated compared to other world-wide shales.
- SC-6. **Section 1.1, Background, page 1-3, last paragraph:** The text states "The background samples collected during the RI are representative of only a portion of the potential area disturbed by the mining operations, and specifically excluded soils derived from and overlying the Phosphoria Formation at the direction of the A/Ts." This is misleading. The Agencies approved collection of soils background samples from nearby undisturbed areas. Since previous mining had effectively removed all surficial outcrops of the Phosphoria Formation at the individual mine site, there were no site-specific Phosphoria Formation background sample locations available. It is incorrect to imply that the A/T "specifically excluded" the Phosphoria from the background dataset based on the fact that site-specific information was preferred. Delete the term "specifically excluded" and replace with "did not include."
- SC-7. **Section 1.1, Background, page 1-4, 1st complete sentence:** The text states "The Phosphoria Formation exposure represents up to approximately 50 percent of the land area disturbed by a typical phosphate mining operation." Provide the approximate percentages for the three P4 mine sites rather than a "typical phosphate mining operation". This information will help inform interpretations of statistics if the data are pooled. The text goes on to state that "The ore bearing Meade Peak member of the Phosphoria formation represents a smaller portion of this (i.e., up to 20 percent) depending on the configuration of the mine pit and waste dumps." Since the Meade Peak Member typically contains the most elevated COPC concentrations within the Phosphoria Formation, and since the Meade Peak Member exposure represents "up to 20 percent" which could mean substantially less in most areas, that the proposed soils background samples data might change the current soils background dataset by some factor. Revise the text to more fully acknowledge the variable range in area of the extent of Phosphoria Formation that is likely to occur at the various mines.
- SC-8. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives.** Identify the proposed background locations here.
- SC-9. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives, item 1.** The text states: "Collection of gamma measurements, through GPS-based gamma surveys, within a selected background reference area that through correlation studies (Objective 4 below) can be used to predict total uranium (mg/kg) and Ra-226 (pCi/g) concentrations in soil..." The presence of other gamma-emitting radionuclides, most notably K-40 but also Th-232 and its daughters, could make the correlation of gamma measurements to U and Ra-226 difficult to impossible. Explain how the SAP intends to determine the influence of these other

radionuclides on this correlation (in item four it is only stated that these data will be used to evaluate gamma abnormalities). For example, if the background area has elevated K-40 relative to the Sites, then a correlation of Ra-226 to gamma measurements at the background areas would underestimate the amount of Ra-226 at the Sites (and vice versa).

- SC-10. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives, item 2.** The text states: Collection of radon flux measurements (i.e., radon release rates from soil surface measured as an activity per unit area and time). The flux measurements will be the basis to predict background radon air concentrations and for the calculation of background risks...” One definition of TENORM is radioactivity that has become more bioavailable due to human activity. This would include enhanced radon releases due to mining the ores. Explain if the radon flux measurements taken over Site wastes will be directly compared to the background radon flux measurements to evaluate this potential?
- SC-11. **Section 1.2.2, page 1-6, On-Site – Activities/Objectives, item 1.** The text states: “1) Collection of gamma measurements, through GPS-based gamma surveys, focused on the source areas (waste rock dumps) within the P4 Sites that: (a) can be used to select sample locations to estimate the maximum and range of uranium (thus Ra-226) concentrations...” The implied assumption in this statement is that U and Ra-226 are in equilibrium. This contradicts the other stated study question of trying to determine whether or not the U daughters are in equilibrium. Please explain and revise as appropriate.
- SC-12. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model).** The text states: “As a result, the rock (ore) with the most elevated uranium concentrations ends up in the slag material after the ore is processed at P4’s processing facility in Soda Springs, Idaho, and is not returned in any significant volume to the Sites (a small volume of slag is stored at the Ballard Shop Area for use in road repair).” Will the site characterization study include an evaluation of whether the returned slag qualifies as TENORM in the storage area and the roads repaired with this material? See also general comment above about the need to refine ARARs during the FS.
- SC-13. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-4, 1st incomplete sentence and paragraph:** The text states that the typical waste rock dumps and backfills are comprised of the upper, middle, and lower waste shale beds of the Meade Peak Member along with portions of the Dinwoody and Wells Formations. The waste rock also contains Rex Chert and the Cherty Shales which also have a much lower gamma radiation response than the ore-bearing units. Please revise accordingly.
- SC-14. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-4, last paragraph.** The text provides an example of a “typical” mine configuration to better understand the distribution of ore to waste in a typical cross-section. The distribution of ore to waste depends primarily on the structural geology which is extremely different among phosphate mine sites in southeastern Idaho due to the complex regional geology. Please clarify that there can be substantial structural variation between mines and the main purpose of this sectional view is to illustrate the fact that background samples have not been collected from soils overlying the Phosphoria Formation.
- SC-15. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-5, 1st paragraph, last sentence:** The issue of site risk is not whether uranium and other COPC concentrations in soils on the Sites may be lower than over the native Phosphoria

Formation ore sequence, the issue is whether the impacts from mining such as waste rock dumps, backfilled pits and unreclaimed pits, in relation to existing Site conditions, pose a risk to human health or the environment. Revise accordingly.

- SC-16. **Section 2.2.2 Conceptual Model (Risk Assessment Conceptual Model), page 2-5, 3rd bullet.** The text states: “Exposure pathways – Direct exposure to gamma radiation, inhalation of radon in indoor air, and uptake of radiological COPCs from soil into fruits and vegetables grown in affected soils.” Is this intended to be a complete list of exposure pathways? If so, there are missing exposure pathways (e.g., inhalation of dust and direct ingestion of soil could factor into a recreational hiker/camper scenario) that should be acknowledged. Explain why these potential pathways are not considered important. For example, were they not included because the relative exposure (and risk) are insignificant compared to the other identified pathways (direct exposure to gamma radiation, inhalation of radon in indoor air, and uptake of radiological COPCs from soil into fruits and vegetables grown in affected soils)? Revise accordingly. Also, considering these are potentially complete exposure pathways, the significance of excluding them will need to be described in the uncertainties. Also, there is no mention of surface water or groundwater pathways. Clarify what data are available to support that these other major media are not potentially contaminated with radiogenic material and therefore need not be studied further.
- SC-17. **Section 2.2.2, page 2-4, Conceptual Model (Risk Assessment Conceptual Model), Page 2-5, 4th bullet:** The text makes reference to livestock and wildlife receptors which have not been mentioned earlier in the document. Clarify if the proposed new data are planned for use in both the HHRA and ERA and if so, exactly how for the ERA. Also, if the data are proposed for use in the ERA, this needs to be made clear in the early sections of the document along with the discussions of the planned use of the data in the HHRA.
- SC-18. **Section 2.2.2, page 2-4, Conceptual Model (Risk Assessment Conceptual Model), page 2-6, 1st paragraph:** Revise to clarify that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario is unlikely and as such, will not be included in the HHRA for those portions of the Sites.
- SC-19. **Section 2.2.2 Conceptual Model (External Exposure), page 2-6, 1st paragraph, last sentence.** Text states: “Gamma rays from the radioactive decay of Ra-226 have the potential to deliver a radiation dose to occupants of structures overlying soils containing U-238.” Technically the external dose depends heavily on the decay products of Ra-226. Revise to read “Ra-226 and its daughters.”
- SC-20. **Section 2.2.2 Conceptual Model (External Exposure), page 2-6, 2nd paragraph, 6th sentence.** Text states: “Note that the concentrations of Ra- 226 in soil can be estimated from concentrations of U-238, assuming (1) secular equilibrium is present in the decay series or (2) consistent ratios of the two are observed, if secular equilibrium is not confirmed in this investigation.” Given the material is waste rock that has not been processed, the only reason that disequilibrium between U and Ra-226 should exist is if Ra is being preferentially mobilized relative to U. If this is the case, such preferential leaching may not be consistent between the different rock formations, or between the proposed background areas and the sites. How will the study differentiate the results to determine whether disequilibrium (if it exists) is different between these variable areas? What will be done if disequilibrium is

discovered in an inconsistent ratio between rock formations and sites, especially if disequilibrium is found in the waste rock at the sites but not found in the similar rock formations at the background site?

SC-21. **Section 2.2.2 Conceptual Model (Radon), page 2-7.** Text states: “Because of the more permeable nature of waste rock compared to pre-mining rock and soil, radon flux could be less inhibited in waste rock (i.e., freer gas movement).” Would this enhanced radon flux cause the waste rock to be defined as TENORM? Please define the direct study question that is being proposed relative to this possibility. See also general comment above about the need to refine ARARs during the FS.

SC-22. **Section 2.2.2, Background Locations and Selection, page 2-7.** The text states that “The character the ore-bearing Phosphoria Formation does not change significantly over a few miles....” Please clarify what “character” means in the context of the proposed work which is to collect representative background soils samples for COPC concentrations in addition to radiological surveys. The notable geochemical variability of the lithologic units of the Phosphoria Formation is well documented in the various phosphate mine EISs. Subsequent text states “The Phosphoria geology and geochemistry is not expected to change significantly over a scale of a few miles.” Please provide references to support this statement. As mentioned earlier in the text, faulting in the Western Phosphate Field occurred after ore formation. Structural folding also occurred after ore formation. Both structural processes result in associated geochemical and mineralogic alterations in nearby stratigraphic units. Additionally, weathering of the Phosphoria Formation, and more specifically the Meade Peak Member, results in substantially altered COPC concentrations between weathered versus un-weathered shales. The differential weathering combined with the varying complex structural settings of the Meade Peak Member does result in significantly different geochemistry over relatively short distances (less than a few miles). Additionally, the spatial distance between the P4 CERCLA sites and the proposed background location is approximately 10 miles which is more than a “few”. Revise accordingly to reflect this information.

SC-23. **Section 2.2.2 Background Locations and Selection, page 2-7.** Text states: “The character the ore-bearing Phosphoria Formation does not change significantly over a few miles, except possibly along the basin edges, in contrast to other types of ore deposits.” Is there data available to directly or indirectly compare the pre-mined concentrations of U in the ores mined from the Sites relative to the ores in the proposed background sites? This type of information may be useful in evaluating whether the proposed reference areas are representative of the conditions near the sites.

SC-24. **Section 2.2.2 Background Locations and Selection, page 2-8, 1st incomplete paragraph.** The text states “For this reason, locations immediately adjacent to the Sites are not available for soils overlying all geologic formations.” The text goes on to state that “Ideally, the background area is one that has been identified for future mining...” The A/T disagrees with this statement and it should be revised something to the effect of “Ideally, background samples should be collected from nearby undisturbed areas with similar geologic and topographic configurations.” Whether an area has been designated as suitable for future mining is a secondary consideration.

- SC-25. **Section 2.2.2 Background Locations and Selection, page 2-8, 2nd paragraph.** The text states “These areas also have the advantage that the geology is well understood through mapping at the surface and in the subsurface by drilling.” This implies that exploration drilling at both background locations has taken place. Revise text to specifically say whether or not exploration drilling has been performed at both background locations. If exploration drilling has taken place, present any data/information that might support the premise that the background areas and the Sites have similar geology, including any geochemical data that may support the similarities.
- SC-26. **Figure 2-4:** It appears that at least one of the proposed radiological survey areas is planned on National Forest System lands at Enoch Valley Mine. Since radon exposure will not be included in the HHRA for FS lands, it is recommended that this location be removed from the plan.
- SC-27. **Section 3.0 Sampling Design – Background and On-Site Areas, page 3-1.** Text states: “The data needed to evaluate risks from these parameters are external gamma, radon flux, radiation dose, and soil concentrations of total uranium and daughters products (e.g., Ra-226).” Delete “radiation dose” from this list. It is a calculated value derived from the data collected, and no direct measurement (e.g., environmental TLDs) is being proposed for this parameter.
- SC-28. **Section 3.1 Background Area Sampling Approach, page 3-3.** In step 3, the text states, “Select a single line of transect across the Background Area that is oriented perpendicular to the geologic units (based on geology and information from Steps 1 and 2) that will be used to collect samples in Steps 4 and 5, below.” Explain what are the specific criteria that will be used to judge which line of transect over another, and why are they relevant to ensuring that the background transect represents the pre-mined conditions of the Sites?
- SC-29. **Section 3.2, On-Site Sampling Approach, page 3-5, step #2.** Based on the size of the hypothetical survey area shown in Figure 2-6, each of the three survey areas could encompass most, if not all of an individual mine. Provide further explanation of potential criteria that will be applied to determine the size of a survey area. The text also implies that the survey areas will not necessarily be distributed between the three mines; that is, the three survey areas could end up being on just one or two of the mines. Clarify if the survey areas may or may not include all three mines.
- SC-30. **Section 3.3.4, Correlation Studies, page 3-9, paragraph 1 (partial), line 1.** Confirm a minimum of 20 correlations as it seems that there will be 20 samples in the background areas (4 geologic units X 5 samples/unit) plus 10 On-Site samples which equate to a minimum of 30 samples for the correlation study.
- SC-31. **Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-10.** Text states: “The background soil samples collected for COPC analyses from soil overlying each of the geologic formations during this sampling effort will be evaluated consistent with the statistical methods and procedures...” Given the number of confounding factors associated with the proposed calculation of a background concentration, how will the calculation of a UCL95 of the mean and USL95 account for:
- Use of composite samples instead of grab samples
 - The effects of eliminating samples as “outliers”

- The uncertainty of proportions of the Sites represented by different geologic formations
- The potential difference between the ore concentrations in the background areas and the ore concentrations at the Sites

SC-32. Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-11, 1st paragraph:

Provide reference's to project documents that include the borelogs and cross-sections in order to support and illustrate that the geologic sequence and pit construction is similar to Ballard, Henry, and Enoch Valley Mines as depicted in Figure 2-2.

SC-33. Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-11, bullets. In

response to previous agency comments regarding the distribution of background samples across the various geologic formations at the mines, P4 has attempted to estimate the typical affected footprint of the three mines and has broken this down further by geologic formation. This is fraught with potential error because the ratios will vary from mine to mine. See also specific comment below.

SC-34. Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-12. In response to previous agency comments regarding the distribution of background samples across the various geologic formations at the mines, P4 has attempted to estimate the typical affected footprint of the three mines and has broken this down further by geologic formation. This is a gross approximation; actual percentages will vary from mine to mine. Furthermore, P4 is proposing to weight the background COPC UCLs of the Mean and USLs based on the relative areas of disturbance of the formations. If available, provide reference to where this approach of weighting subpopulations has been used previously in establishing soils background under CERCLA.

Additionally, from a statistical standpoint, the A/T believes there are inherent concerns regarding this concept, as discussed below.

Calculated UCLs of the mean tend to be closer to the Mean when variability in the results is smaller and when the number of samples is larger. With skewed right data sets, the average of four UCLs of the Mean (using 20 samples) will tend to be higher than the calculated UCL of the Mean for the combined 80 samples.

Developing a statistically defensible UCL of the Mean for a population is not achieved by averaging UCLs of the Mean for subsets of that population. One does not necessarily expect such an average to provide an appropriate 95% UCL of the Mean for the overall population. A project team might find that such an averaging approach suits their needs, but they would not be able to present it as a statistical UCL of the Mean.

To investigate how different these approaches can be, an initial effort with randomly generated normal data was reviewed with the ratio of the average of four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples) ranging from about 1.06 to 1.14 for coefficients of variation (CoVs) ranging from about 0.3 to 0.9. A CoV is simply the standard deviation divided by the mean. Thus, it offers a convenient measure of the relative variation present in a data set. Noting that increasing CoV with normally distributed data (a symmetrical, bell shaped distribution) lightly increased the ratio of the average of four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples), promoted curiosity as to how much the ratio might increase if the data set were skewed right as seen so frequently in environmental data.

To pursue that concern, eight sets of data for each of three relative skewness categories from randomly generated gamma distribution data sets provided the following results. Each set of data included four subsets of 20 results (80 overall results per data set). Gamma distributed data can range from symmetrical to very skewed. With these data the UCLs of the Mean were calculated using ProUCL.

Evaluation of Randomly Generated Gamma Distribution Data Sets

Relative Skewness	Ratio of Average of Four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples)
Low	Median Ratio = 1.06 with range of 1.05 - 1.07
Moderate	Median Ratio = 1.20 with range of 1.05 - 1.27
High	Median Ratio = 2.59 with range of 2.01 - 2.88

As can be seen in the table above, when skewness is relatively low, there is only a minor (a few percent) difference between the average of four UCLs of the Mean (using 20 samples) and the calculated UCL of the Mean for the combined 80 samples (as was seen with the normally distributed data). As skewness increases, the difference becomes much more pronounced. The range of CoVs in this randomly generated data set resemble those encountered in actual environmental data. These included calculated CoVs of about 0.2-0.4 for the low skewness category, 0.7-1.4 for the moderate skewness category, and 1.7-3.8 for the high skewness category.

For USLs, the effect of weighting by formation is more complicated than that with UCLs of the Mean. With UCLs of the Mean, we are primarily concerned with the combined data set offering a calculated UCL of the Mean lower than the average of the subset UCLs of the Mean. With USLs and other background threshold values, one would expect some of that, but one would often expect the combined USL to be most dominated by the subset with the highest concentrations. Thus, for some cases, the combined USL would be higher than the weighted USL. There would not be as clear a prediction as to which version would be higher.

Therefore, based on the above analysis, weighting by geologic formation may result in indefensible background statistics. Weighting would likely inflate the UCL of the Mean and could affect the USL in an unpredictable manner. Therefore, the A/T requires that P4 report the following unpooled statistics for each COC for each of the four formations:

- Box and whisker plots
- The calculated UCLs of the Mean

- The calculated USLs

Additionally, the A/T requires that P4 report the following statistics for the pooled data for each COC:

- The weighted values for the 95%UCLs as proposed in the SAP
- The unweighted (combined 80 samples) values for the 95%UCLs
- The weighted values for the 95%USLs as proposed in the SAP
- The unweighted (combined 80 samples) values for the 95%USLs

Together, this information will allow the A/T and P4 make the most informed decisions for establishing final soil background concentrations for the P4 Mines. Revise the work plan accordingly.

SC-35. **Table 2-1, Step 1, 4th paragraph:** The text states that the background samples collected during the RI specifically excluded soils derived from and overlying the Phosphoria Formation. As noted in a previous comment, this is misleading and the term “specifically excluded” should be replaced with “did not include.”

Appendix A: Field Sampling Plan

- A-SC-1. **Section 4.3, GPS-Based Gamma Survey – Background and On-Site, page 4-4, bullets.** Add statement clarifying if the GPS gamma measurements are continuous or if data are collected at intervals.
- A-SC-2. **Section 4.3, GPS-Based Gamma Survey – Background and On-Site, page 4-4, last paragraph.** Other than defining the upper and lower Meade Peak contact, describe how, if at all, the gamma reading may affect the decision as to where the transect will be located; e.g., will generally higher or lower gamma readings overall be a determining factor?
- A-SC-3. **Section 4.4, Radon Flux Measurements, page 4-5, paragraph 2, line 2.** Explain what is meant by a “right circular cylinder” as this reader is unfamiliar with such.
- A-SC-4. **Section 4.4.2, On-Site, page 4-6, bullet #3.** Explain how the point will be randomly selected for placement of the radon canister; e.g., will the x and y coordinates be generated by a random number generator?
- A-SC-5. **Section 4.6.2, GPS-Based Gamma Surveys and Composite Soil Sampling, page 4-10, 1st paragraph, last sentence.** Explain if “along 5-ft transects” means the transects will be 5 ft in length or 5 ft spacings.
- A-SC-6. **Section 4.8, Equipment Decontamination, page 4-11, bullet 1, sub-bullet 3.** Delete “or distilled”. Distilled water should not be used in the decontamination process consistent with Section 2.2.6 of the QAPP.
- A-SC-7. **Section 5.1, Sample Designation, page 5-2, bullet 8.** This reader is not sure how the blind duplicate remains "blind". Possibly rewording of the language will help. Revise accordingly.

- A-SC-8. **Section 5.1, Sample Designation, page 5-2, paragraph 1.** The example of “**1407-MBF-RC01-SS**” is inconsistent with the unique identification number explained above as **SS** is not mentioned under **c**. Rectify.
- A-SC-9. **Section 5.2, Sample Handling and Shipping, page 5-3.** This section seems to be mislabeled as the list includes items above and beyond what is needed for shipping and handling. Also, include in the list necessary field equipment such as auger, trowel, and bowl, and miscellany such as pens, extra batteries. Revise accordingly.

Appendix B – Quality Assurance Project Plan

General Comments

- A-GC-1. Overall, the metals portion of the QAPP is appropriate. The methods and QC checks are detailed and the example validation reports provide sufficient information to discern the reasons for individual data qualification. No changes are needed.
- A-GC-2. EPA method 6020 was not shown for analysis of Boron, Molybdenum & Uranium, but appears to have been adequately covered in the QC tables and Lab MDLs. No changes are needed.

Specific Comments

- A-SC-10. **Section 1.4.4.1, Precision, page 1-8, paragraph 2, line 3.** Explain what a “report of investigation” is. This term is also used in several subsequent sections.
- A-SC-11. **Appendix B, SOP Soil-1, Section 3.1, Drying.** Text should indicate either the reference method for performing the initial percent solids or the drying temperature (e.g., 105°C) that went in to the determination. Either ASTM D2216 or the CLP ISMO1.2 SOW may be used as suitable references.

Editorial Comments

General Editorial Comments

Be consistent on whether the word data is singular or plural. Plural is preferred.

Change “Roskelly” to “Roskelley”.

Specific Editorial Comments

1. **Figure 2-4, page 2-11, Sampling Approach, bullet 6)b, line 1.** Delete the second “soil sample”.
2. **Section 3.1, page 3-3, bullet 3, line 21.** Change “overly” to “overlie”.
3. **Section 3.2, page 3-5, bullet 1), line 5.** Change “has” to “have” for subject-verb agreement.
4. **Section 3.2, page 3-6, bullet 4)b, line 2.** Delete the second “soil sample”.
5. **Section 3.3.5, page 3-10, paragraph 1, line 1.** Change “Area” to “Areas”.

6. **Section 3.3.5, page 3-11.** There are two pages labeled 3-11, one before Figure 3-1 and one following Figure 3-2. Correct accordingly.
 7. **Table 2-1, Step 1, page 2, paragraph 1 (partial), line 10.** Insert “is” between “risk” and “appropriately”.
 8. **Table 2-1, Step 2, page 3, Estimation statement, paragraph 1, line 5.** Change “portion” to “portions”.
 9. **Table 2-1, Step 2, page 4, Estimation statement, paragraph 1, line 2.** Delete the second comma.
 10. **Table 2-1, Step 2, page 4, Estimation statement, paragraph 1, line 4.** Delete the period following the question mark.
 11. **Table 2-1, Step 3, page 4, bullet 2, line 2.** Change the comma to a period.
 12. **Table 2-1, Step 4, page 5, bullet 1.** Add a period to the end of the bullet.
 13. **Table 2-1, Step 5, page 6, paragraph 3, line 1.** At “randomly” what?
 14. **Table 2-1, Step 5, page 6, paragraph 4, line 5.** Change “previous” to “previously”.
 15. **Table 2-1, Step 5, page 6, paragraph 5, line 4.** Delete the first “and”.
 16. **Table 2-1, Step 5, page 6, paragraph 5, line 5.** Insert “will be” between “samples” and “collected”.
 17. **Table 2-1, Step 5, page 7, paragraph 1 (partial), line 2.** Change the semi-colon to a comma.
 18. **Table 2-1, Step 5, page 7, paragraph 4, line 1.** Identify what the “15 randomly selected” are, presumably sites.
 19. **Table 2-1, Step 5, page 7, paragraph 5, line 3.** Delete “and”.
 20. **Table 2-1, Step 5, page 7, paragraph 5, line 4.** Change to “. . . made; and soil samples will be collected . . .”
 21. **Table 2-1, Step 5, page 7, paragraph 5, line 7.** Change the semi-colon to a comma.
 22. **Table 2-1, Step 6, page 8, paragraph 1, line 5.** Change to “Background”.
 23. **Table 2-1, Step 7, page 8, paragraph 1, sentence 1.** This sentence reads awkwardly, should perhaps “are based on” be inserted between “design” and “knowledge”? Revise accordingly.
- Appendix A – Field Sampling Plan
24. **Section 3.1.2, page 3-3, bullet 3 (partial), line 10.** Change “overly” to “overlie”.
 25. **Section 3.2.2, page 3-5, bullet 1, line 5.** Change “has” to “have” for subject-verb agreement.
 26. **Section 4.1, page 4-1, section title.** Change to “Site Access, Logistics, and Safety”.
 27. **Section 4.1, page 4-1, paragraph 1, line 4.** Delete “at”.
 28. **Section 4.1, page 4-1, paragraph 2, line 1.** Delete the first “stored”.
 29. **Section 4.2.1, page 4-2, paragraph 1, line 3.** Change to “Wells Formation,”.
 30. **Section 4.2.1, page 4-2, paragraph 1, line 5.** Change “area” to “areas”.

- 31. **Section 4.4, page 4-5, paragraph 2, line 9.** Change “are” to “is” for subject-verb agreement.
- 32. **Section 4.5, page 4-7, paragraph 4, line 4.** Change to “. . . three strata sampled and a total . . .”
- 33. **Section 4.5, page 4-7, paragraph 5, line 3.** Change to “accomplish” to “accomplished”.
- 34. **Section 5.1, page 5-2, sub-bullet 4.** Tab “Caldwell Canyon Background Area” over.
- 35. **Section 5.1, page 5-2, bullets 4-7.** Indent “DW”, “MP”, “RC”, and “WF” as sub-bullets.
- 36. **Section 5.1, page 5-2, bullet 8.** Reword the language inside the parentheses as it is confusing to this reader.

Appendix B – Quality Assurance Project Plan

- 37. **Section 1.4.2, page 1-2, paragraph 1, line 5.** Change to “. . . analysis; laboratory-specific . . .”
- 38. **Section 1.4.2, page 1-2, paragraph 3 (Background Investigation), lines 2&3.** Change to “(1) the Meade Peak, (2) the Rex Chert/Cherty Shale Members of the Phosphoria Formation, and (3) the Wells Formation.”
- 39. **Section 2.7.3, page 2-13, paragraph 2, line 1.** Change to “3rd-party”.
- 40. **Table 2-1.** Change to “ ≤ 6 °C” in the Preservation column for both occurrences.
- 41. **Table 2-1, footnotes.** Change to “degrees”.

Attachment B, SOP SOIL-1

- 42. **Section 2.0, Target Analytes, page 1, paragraph 1, line 1.** Change “19” to “20” based on target analytes listed in Table 2-1.

References

- USEPA. 2003. *Guidance for Obtaining Representative Laboratory Analytical Subsamples From Particulate Laboratory Samples*. EPA/600/R-03/027. November.
- USEPA. 2013. *ProUCL Version 5.0.00 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*. EPA/600/R-07/041. September.

***A/T Comments on P4's Radiological Site and Background
Investigation Sampling and Analysis Plan Draft Final Revision 1,
March 2014 and P4's Responses to the A/T Comments, June 2014***

Transmitted to A/T on June 18, 2014

P4 Response to A/T comments (dated May 23, 2014) on P4 Production, LLC Radiological Site and Background Investigation Sampling and Analysis Plan Draft Final Revision 1, prepared for P4 Production by MWH, March 2014.

General Comments

GC-1. The premise is that data collected at reference areas in Caldwell Canyon and at Blackfoot Bridge would be representative of background at Ballard, Henry, and Enoch Valley mines. Some of the specific comments below note that chemical alteration and weathering of bedrock has been observed from one mine to another and even within the scale of an individual mine. As soil samples will be taken at background sites from areas overlying the Wells Formation in the reference areas, it will be possible to compare these results to background data collected in 2009 on Wells Formation near the sites to give some indication if this theory is correct. However, no additional sampling is planned for Dinwoody Formation. It is recommended P4/Monsanto include sampling of soils overlying the Dinwoody Formation in the background reference areas for further comparison to the historic mines background data to further evaluate representativeness.

P4 Response (GC-1): *Many of the considerations identified in this comment and the other related comments below are valid issues. Not only is there variability associated with the geology and soil forming process, but there is sampling and analytical variability. It is difficult to isolate the geochemical variability. The most difficult variable to address is assuring that one is sampling over the same stratigraphic (rock/soil) units that are impacted by the mining activity given the weathered soil surface that masks the underlying stratigraphy. That is why we have proposed systematic sampling transects perpendicular to stratigraphy in the background areas for those units wholly disturbed by the mining. However, given these considerations, it is our impression based on the existing background data set that the gross trace metal geochemistry of the Dinwoody and Wells Formation are not locally that variable, although there are likely slight differences in trace metal content expected between the thinly bedded mudstone and limestone beds in the Dinwoody Formation, and the sand and limestone beds in the Wells Formation. It was our intent to have an equally weighted sample set for each formation.*

In consideration of this comment, we are proposing to collect ten additional samples from soils formed over the Dinwoody Formation for comparison to the existing Dinwoody background soil data. There will be five samples collected from Dinwoody Formation at each of the two background areas. Soil sampling will be performed according to the same methods and procedures as the background samples collected from the other geologic formations. These samples would only be used for qualitative comparison, and excluded from the background data set in favor of the existing Dinwoody background data located at the Sites.

More generally, this comment and several of the other A/T comments expresses concerns regarding the representativeness of the selected background areas. It is acknowledged that the preferred background data would be derived from a detailed sampling program prior to mining of the specific ore deposit, such as is conducted as part to the current NEPA process; and that the areas identified are not “ideal” background locations because they are near but not at the legacy mine sites. However, this situation is not uncommon when addressing background for legacy mines. For mine sites and mineralized areas, in general, background representativeness is often a significant issue because the metals of concern existed in an enriched form in the environment for many millennia before man discovered these deposits and began mining them. Because mining removes the mineralization from mined soils or has contaminated the “background” soils, evaluating mineralized reference areas (other similar nearby deposits or drainages) is often the only way to make an assessment of conditions prior to mining (e.g., Midnite Mine RI for soil, sediment, surface water, and groundwater).

Fortunately, the SE Idaho Phosphate District contains a type of mineralization that is relatively uniform in nature, over large areas, due to its depositional environment when it was formed and was only disturbed after deposition by tectonic activity that resulted in deformation including faulting and folding of the sedimentary beds, and specifically of phosphate beds. The phosphate originally was deposited as continuous sedimentary beds over a large portion of the inland Permian sea floor/sedimentary basin (Perkins and Piper, 2004). Current mining has not exhausted the phosphate ore in the district, so many similar unmined reference areas exist. We plan to collect samples from similar unmined reference areas located nearby and complete the background soil data set for the P4 Sites. Radiological sampling was not discussed in this comment, but it is also important to collect representative background and on-site data for radiological constituents for characterization purposes and so that accurate Site risks can be calculated.

- GC-2. One of the more important study questions relates to the comparison of site concentrations of radiological contaminants of surface materials (mostly waste rock) to background soil concentrations. Many of the statements within the Sampling and Analysis Plan (SAP) appear to be geared towards answering the fundamental question of whether or not the removal of ore has had the effect of decreasing site U and Ra-226 concentrations (where waste rock is exposed at the surface) relative to soils in background areas, but it is not clearly stated as the highest level study question to be answered.

P4 Response (GC-2): *The principal study questions for the proposed investigation are detailed in the Data Quality Objectives (DQOs) provided in Table 2-1. These questions are as follows:*

Study Question 1: Are representative background data available to accurately evaluate incremental risk associated with uranium series radionuclides and other Site COPCs?

Study Question 2: Given that total uranium data are available for the Sites, are additional data needed to reduce the uncertainty in the risks posed to human health and the environment from uranium and associated radiogenic daughter products both at the Sites and in a suitable Background Area(s)?

It is currently unknown how COPC soil concentrations from the On-Site waste rock piles compare to representative background concentrations. Collection of representative background COPC concentrations and the calculation of more accurate On-Site total and incremental risk estimates are the primary objectives of this investigation. The question regarding any effect removal of the ore containing the highest uranium concentrations from the Sites had on the overall radiologic landscape of the Sites is of interest, but it is not directly a fundamental question of the study. It will, however, be addressed as part of the characterization of the radiologic background. Therefore, changes to the SAP are not required.

- GC-3. Although the immediate objective is characterizing radiological properties surface material materials and soils, it will be necessary to refine ARARs in the forthcoming feasibility study for Ballard. One question to sort out is whether or not the waste rock qualifies as Technologically Enhanced Naturally Occurring Radioactive Material (TENORM). Ultimately the ARARs associated with radioactivity that are carried forward into the ROD may depend on whether the waste rocks are or are not TENORM.

P4 Response (GC-3): *Comment noted, as suggested by EPA in the June 2, 2014 project conference call.*

P4 and the A/T agreed during development of the P4 Sites RI/FS Work Plan that waste rock at the P4 Sites is characterized as NORM (see comment resolution for SC#125 Appendix F of P4 Sites RI/FS Work Plan [May 2011]). Regardless, the constituents in the waste rock will be evaluated appropriately in the risk assessment, regardless of the nominal definition of the material, and ARARs will be addressed in the Feasibility Study.

- GC-4. The current sampling plan offers the opportunity to reduce uncertainties associated with previous sampling. The A/T recommends that P4 consider replacing the 5-point composites with a larger number of points (aliquots) per composite in an attempt to be more in-line with more recent sampling guidance (ITRC, 2012). This may reduce data variability and improve representativeness of BTV estimation. For clarification, the A/T expects that the total number of composite samples per geologic formation would remain the same (20 composite samples per formation).

Before deciding to add increments to each composite sample, comparability with previous, 5-point composite samples should be evaluated before adding the extra increments (aliquots). This should not be a concern for “new data” including radiological parameters or background in the Meade Peak, Rex Chert and Cherty Shale Members because samples have not been previously collected, but might be problematic when pooling with the existing Wells and Dinwoody Formation background samples. Include sample processing procedures consistent with current EPA practices (USEPA 2003).

P4 Response (GC-4): *P4 understands the recent guidance regarding Incremental Sampling Methodology (ISM). However, P4 maintains that the proposed 2014 sample collection be consistent with the methods and procedures specified in the A/T-approved 2009 Supplemental Mine Waste Rock Dump and Facility Soil and Vegetation Characterization Sampling and Analysis Plan (MWH, 2009). The 2009 Soil and Vegetation Characterization SAP was reviewed and approved by the A/Ts, with the 2003 EPA guidance and other EPA documents as references. Given that data collected in 2009 and 2014 will be pooled among the various geologic units, by using similar methods and procedures these data should be comparable. New five-point composite data will be available for comparison to 2009 Wells and Dinwoody Formation concentrations.*

GC-5. As noted in previous discussions and correspondence, the inclusion of outliers in the computation of the various decision statistics tends to yield inflated values of those decision statistics, which can lead to incorrect decisions. This is especially important when calculating USLs. As EPA notes in USEPA (2013):

“To provide a proper balance between false positives and false negatives, the upper limits described above, especially a 95% USL (USL95) should be used only when the background data set represents a single environmental population without outliers (observations not belonging to background). Inclusion of multiple populations and/or outliers tends to yield elevated values of USLs (and also of UPLs and UTLs) which can result in a high number (and not necessarily high percentage) of undesirable false negatives, especially for data sets of larger sizes (e.g., $n > 30$).”

Therefore, similar to past practice, the A/T will continue to require that the background datasets be rigorously evaluated for the presence of outliers before accepting revisions to final BTVs. In addition, the evaluation of the data set will be necessary confirm or verify the appropriate statistical measure (e.g., 95/95 UTL vs. 95% USL) for the final BTVs.

P4 Response (GC-5a): *Agreed. The background data will be statistically evaluated to identify and remove outliers, as appropriate, consistent with methods and procedures described in the Background Levels Development Technical Memorandum Ballard, Henry, and Enoch Valley Mines Remedial Investigation and Feasibility Study – Final [Background Levels Tech Memo (MWH, 2013a)]. In addition, results of the updated statistical evaluation will be reviewed to help ensure that the appropriate statistical measure is recommended. However, please note that the 95% USL (USL95) was recommended for all of the media (soils, surface water, groundwater, etc) in the Background Levels Tech Memo (MWH, 2013a) for detected analytes with sufficient sampling results to perform a statistical evaluation. The USL95 will also be recommended for the updated upland soils background levels, when appropriate.*

GC-5. The sampling plan should be revised to include tables that summarize the number, location, and type of samples collected along with the analytical methods and associated reporting limits relative to risk-based values.

P4 Response (GC-5b): *A table will be included that summarizes sample numbers, locations, analytical methods and reporting limits compared to the risk-based values.*

- GC-6. As required under the 2009 AOC, all deliverables are to be submitted as “draft” for Agency review and approval. This document was submitted as “Draft Final Rev01”. Revise to clarify this is an initial draft of the document.

P4 Response (GC-6): *The original Draft Rev0 of the SAP was submitted in June 2011. The March 2014 version was revised to incorporate A/T comments on the Draft Rev0 and was appropriately named Draft Final Rev 01. P4 will revise to name the next version of the SAP Final Rev02.*

- GC-7. Revise for consistency in use of “Phosphoria Formation” and “Phosphoria formation.”

P4 Response (GC-7): *The one occurrence of this is located in Section 1.1 on Page 1-4 and will be corrected as requested.*

- GC-8. Note that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario for non-transient media is unlikely and as such, will not be included in the HHRA for those portions of the Sites. The residential risk scenario should be included for surface water and groundwater due to the transient nature of these media. Please revise all relevant portions of this SAP accordingly.

P4 Response (GC-8): *Please note that the exposure scenarios, exposure media and exposure pathways to be evaluated for the P4 Mine Sites were defined in the A/T-approved Remedial Investigation and Feasibility Study Work Plan for the P4 Mine Sites [RI/FS Work Plan (MWH, 2011)]. Consistent with Risk Assessment Guidance for Superfund (RAGS) Volume I: Human Health Evaluation Manual – Part A (USEPA, 1998) and the A/T-approved RI/FS Work Plan (MWH, 2011), the residential receptor will be evaluated for all portions of the Henry and Enoch Valley mines to evaluate whether these sites are appropriate for future unrestricted land use or if land use controls (LUCs) are required. Following completion of the Feasibility Studies for the Henry and Enoch Valley mines, the National Forest System (NFS) and Bureau of Land Management (BLM) may opt to disregard risk assessment results for residential receptors when making risk management decisions regarding NFS and BLM lands.*

- GC-9. In the Background Section of the current SAP, P4 states that researchers have noted that the Meade Peak Member is enriched in several COPCs compared to their respective averages in world-wide shale and reference Herring and Gauch, 2004 to support this statement. The text goes on to state that it is believed that in undisturbed (pre-mining) areas, the enriched concentrations of COPCs in the Meade Peak Member likely will contribute to an elevated background in soils overlying the Phosphoria Formation and may result in elevated concentrations in soils downslope of formation outcrops. The text does not clarify by whom it is believed that in undisturbed areas the enriched concentrations of COPCs in the Meade

Peak.... The text must be revised to clarify that this is a working hypothesis that will be evaluated using data collected under this proposed SAP. In addition, this section does not acknowledge that Herring and Gauch, 2004, also noted substantial differences in COPC “enrichment” associated with weathering and that those undisturbed sections of the Meade Peak Member closest to the surface had noticeably lower concentrations of COCPs compared to undisturbed Meade Peak at depth. Revise to place this observation in the context of the proposed work (i.e., outcrops of the Phosphoria Formation will be weathered and soils collected from those outcrops most likely will *not* contain the highly “enriched” COPC concentrations as P4 suggests for the rationale to collect additional background soil samples).

P4 Response (GC-9): *The opening paragraph in Section 1.1 will be revised as shown below. In addition, a subsequent paragraph will be added to further clarify and define the conceptual model (underlining and strikeout are used to show the changes).*

At the Sites, the middle or center waste shale (CWS), found between ore horizons of the Meade Peak Member, is one of the primary rock types in the waste rock dumps and contributes most of the COPC loading detected in soils, surface water, and groundwater. It is also ~~believed possible~~ that in undisturbed (i.e., pre-mining) areas, the enriched concentrations of COCPs in the Meade Peak Member ~~likely will contribute to~~ could result in elevated background in soils overlying the Phosphoria Formation and ~~may result possibly in elevated concentrations~~ in soils downslope of formation outcrops due to mass creep.

The occurrence of an elevated concentration of an element in soil when the concentration of the element in parent bedrock is elevated is a commonly recognized geochemical principle, where the soil that forms on a specific lithology will retain some of the geochemical characteristics of the parent rock including elemental enrichments and depletions (Levinson, 1980). This principle is a basis for the use of soil sampling in mineral exploration, and has been used successfully for locating elemental enrichment (ore deposits) in the underlying bedrock (see Levinson, 1980, for examples). However, it also needs to be stated that the degree to which concentrations of individual elements in a soil reflect elemental composition of the underlying bedrock will vary by element because of the unique geochemical behavior of the individual elements in the geologic unit and the climactic conditions present during the soil forming process. For example, the solubility of an individual element under the specific soil pH and Eh will have a direct effect on whether the element is possibly enriched (e.g., nickel and chromium in lateritic soils), or depleted relative to the bedrock. This has been observed in weathered Meade Peak where mercury, nickel, and selenium are readily depleted in soils overlying the formation, but silver, barium, uranium, vanadium, and zirconium are slightly enriched (Herring and Grauch, 2004). Other elements including chromium, copper, molybdenum, antimony, and zinc may also be slightly depleted in the soils relative to the Meade Peak. However, it should also be noted that while the concentration of an element may be lower in the soil relative to the Meade Peak Member, the absolute concentration still may be

elevated relative to other soils in the area, and with respect to regulatory and risk-based criteria.

Levinson, 1980. Introduction to Exploration Geochemistry. Second Edition, Applied Publishing, Wilmette, Illinois, 924 p.

It was observed in the previous soil sampling during the pre-2004 regional studies that selenium was not notably enriched in native soils over Phosphoria Formation consistent with the discussion above. However, the issue has not been addressed using methods consistent with the P4 RIs, nor for all the COPCs including, most notably, arsenic and uranium.

Specific Comments

- SC-1. **Section 1.1, Background, page 1-2, 1st paragraph:** The text states that it is believed that in undisturbed areas the enriched concentrations of COPCs in the Meade Peak Member will likely contribute to an elevated background in associated soils. However, Herring and Grauch, 2004, noted that COPC concentrations are greatly reduced due to weathering, so one could reasonably expect such weathering would have occurred over time on the “undisturbed” outcrops of the Meade Peak Member such that those soils may no longer be considered “enriched” in COPC concentrations relative to other naturally-occurring shales in the Western United States. Revise accordingly.

P4 Response (SC-1): *Please see the response to comment GC-9 which presents a revision to Section 1.1. At issue is not whether the soil is enriched compared to “other naturally occurring shales”, but is enriched compared to other soils in the area, most notably those that formed over the Dinwoody and Wells Formation, which currently represent the entire background soils data set. Testing the hypothesis that the background concentrations of certain elements are elevated over the Phosphoria Formation units relative to the Dinwoody and Wells Formations is a major goal of the sampling program presented in the SAP so that speculation around this issue can be reduced.*

- SC-2. **Section 1.1, Background, page 1-2, 3rd paragraph, last sentence:** The text states “The evaluation of human health risk from uranium series radionuclides in the **various media** [bold emphasis added] at the Sites needs to address both chemical and radiological risk.” Revise to clarify that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario is unlikely and as such, will not be included in the HHRA for those portions of the Sites. Additionally, the only human health radiological risk would be from radon exposure within an enclosure (such as a residence). It is unclear why media other than soils would need to be evaluated for radiological risk for the other portions of the Sites. Clarify as needed.

P4 Response (SC-2): *Please refer to our response to GC-8 in regard to the evaluation of human health risks for residential receptors. The reference to “various media” in the subject statement will be revised to “soil and indoor air”.*

SC-3. **Section 1.1, Background, page 1-2, last paragraph:** The text states “Results of the Ballard Mine HHERA show that the chemical and/or radiological risks associated with COPCs that are naturally enriched in the Meade Peak Member exceed acceptable risk or hazard criteria.” The text goes on to state “For example, chemical risk estimates for arsenic exceed the State of Idaho’s acceptable cancer risk criterion of 1×10^{-5} for a hypothetical future resident and a current/future Native American exposed to arsenic in upland soil.” It is important to note that arsenic is not one of the COPCs identified by Herring and Grauch, 2004, as being enriched in the Meade Peak Member. The text goes on to state “In addition, the chemical noncancer hazard estimates for a current/future Native American exposed to arsenic, selenium, total uranium, and several other COPCs in culturally significant plants grown in upland soil, and for a hypothetical future resident exposed to arsenic, selenium, thallium, zinc and several other COPCs in fruits and vegetables grown in upland soils, exceed the State of Idaho and USEPA acceptable hazard quotient (HQ) of 1.” Herring and Grauch, 2004, note that the trace elements most easily removed by weathering include selenium and to a lesser extent, chromium, copper, molybdenum, antimony and zinc. Again, given the current conceptual model for the Sites, one would expect the current COPC concentrations in the overburden waste rock near the surface to represent relatively highly weathered geochemical conditions with reduced COPC concentrations compared to undisturbed Meade Peak Member material at depth. Please revise accordingly.

P4 Response (SC-3): *See the revision presented in response to comment GC-9, and the associated response to Comment SC-1. Furthermore, it is noted that the mean arsenic concentrations given by Herring and Grauch (2004) for the unweathered (unaltered) Meade Peak Member units range from 14 to 56 ppm, with the higher concentrations occurring in the waste shale units. The weathered (altered) concentrations have a very narrow range between 21 and 24 ppm with very little difference between the degrees of weathering (alteration) suggesting there may not be much depletion of arsenic in soils overlying the Meade Peak units. Herring and Grauch (2004) state that arsenic is not removed by alteration. What is most notable, is the concentrations in the Meade Peak Member in comparison to the background level used in the Ballard RI of 11.5 mg/kg (ppm) and a screening level of 0.39 mg/kg. It is possible that if the background soil concentration over the Meade Peak is between 20 – 25 mg/kg, the weighted average would not increase substantially from the current background concentration. However, the difference for uranium may be much more significant with the mean reported for the highly weathered samples being 68 ppm (slightly enriched over the least weathered samples). This is compared to the background soil concentration used in the Ballard RI screening of 1.61 mg/kg and a screening limit of 5 mg/kg. Here again, a major goal of this Work Plan is to reduce the speculation presented in this comment and comment response by quantifying the background soil concentrations overlying the units of the Phosphoria Formation.*

SC-4. **Section 1.1, Background, page 1-3, 2nd paragraph, 2nd sentence,.** The text states: “This overestimation of radiogenic human health risks in the Ballard Mine HHERA (MWH, 2013a) are likely due to (1) the sequential decay modeling from total uranium concentrations in soil...” Given that the uranium present is in the form of ores that have not been chemically processed/alterd, the assumption that all uranium daughters are present in a

state of equilibrium is a very reasonable one. In fact, disequilibrium would be a condition that would have to be carefully explained if it is being argued that any uranium present is not TENORM. Please explain why an assumption of equilibrium is being considered to be causing overestimation of risks.

P4 Response (SC-4): *Please refer to A/T Specific Comment 125 (SC#125) on the Draft RI/FS Work Plan (MWH, 2010) which requested that radiogenic risk from total uranium (U) be evaluated assuming that total U is effectively 100% U-238 and that Ra-226 activities are equivalent to U-238 activities. P4 believes that these simplified assumptions resulted in an overestimation of risks associated with Ra-226 and radon-222 in the human health risk assessment (HHRA) for the Ballard Mine (MWH, 2013b). The text will be revised as follows: “This overestimation of radiogenic human health risks in the Ballard Mine HHRA (MWH, 2013a) is likely due to (1) the conservative assumptions used in sequential decay modeling of Ra-226 and radon-222 activities from total uranium concentrations, and (2) the fact that concentrations of radionuclides in background, as determined from soil samples collected near the Sites during the RI, are not representative of the complete geologic sequence in this historic mining district and biased low.*

- SC-5. **Section 1.1, Background, page 1-3, 2nd complete paragraph, last sentence:** As commented on previously, arsenic is not one of the COPCs noted by Herring and Grauch as elevated compared to other world-wide shales.

P4 Response (SC-5): *See preceding responses to comments GC-9, SC-1 and SC-3. Whether or not arsenic is elevated compared to other world-wide shales is notable, but not specifically relevant to the discussion in this portion of Section 1.1. However, the preceding text in this portion of the section does imply that the enrichments presented in Herring and Grauch (2004) are the basis of the discussion. The preceding text in the 2nd sentence of the final (incomplete) paragraph on page 1-2 will be revised to read as follows:*

“Results of the Ballard Mine HHRA show that the chemical and/or radiological risks associated with COPCs that are naturally ~~enriched~~ elevated in the Meade Peak Member, compared the adjacent geologic units, exceed acceptable risk or hazard criteria.”

- SC-6. **Section 1.1, Background, page 1-3, last paragraph:** The text states “The background samples collected during the RI are representative of only a portion of the potential area disturbed by the mining operations, and specifically excluded soils derived from and overlying the Phosphoria Formation at the direction of the A/Ts.” This is misleading. The Agencies approved collection of soils background samples from nearby undisturbed areas. Since previous mining had effectively removed all surficial outcrops of the Phosphoria Formation at the individual mine site, there were no site-specific Phosphoria Formation background sample locations available. It is incorrect to imply that the A/T “specifically excluded” the Phosphoria from the background dataset based on the fact that site-specific information was preferred. Delete the term “specifically excluded” and replace with “did not include.”

P4 Response (SC-6): *The revision will be made as requested.*

SC-7. **Section 1.1, Background, page 1-4, 1st complete sentence:** The text states “The Phosphoria Formation exposure represents up to approximately 50 percent of the land area disturbed by a typical phosphate mining operation.” Provide the approximate percentages for the three P4 mine sites rather than a “typical phosphate mining operation”. This information will help inform interpretations of statistics if the data are pooled. The text goes on to state that “The ore bearing Meade Peak member of the Phosphoria formation represents a smaller portion of this (i.e., up to 20 percent) depending on the configuration of the mine pit and waste dumps.” Since the Meade Peak Member typically contains the most elevated COPC concentrations within the Phosphoria Formation, and since the Meade Peak Member exposure represents “up to 20 percent” which could mean substantially less in most areas, that the proposed soils background samples data might change the current soils background dataset by some factor. Revise the text to more fully acknowledge the variable range in area of the extent of Phosphoria Formation that is likely to occur at the various mines.

P4 Response (SC-7): *There is a considerable degree of uncertainty in calculating the numbers suggested. This is because the accuracy of the geologic mapping of the pre-mine surfaces is based on regional geologic maps digitized from large scale maps. There is significant inaccuracy associated with both the mapping scale and the digitizing process. While we have accurate mapping of the waste rock dumps and mine pits, both the absolute position of the formation contacts and unit thicknesses are not sufficiently accurate to derive numbers that would have an accuracy better than the proposed weighting approach. Mapping at the mine level by Monsanto for Henry and Enoch Valley focused on the Meade Peak ore units and little if any detailed data are available on the contacts for the other relevant units. The Ballard Mine is even a more difficult issue because of the complex geology and amount of alluvial/colluvial cover that was present. The approach presented in Section 3.3.5 of the Work Plan, based on relative unit thicknesses, was adopted and has the advantage that it can uniformly be applied across all the Sites. To improve the accuracy of the alternative approach, it would be necessary to improve on the geologic mapping for each of the mines using all existing data that can be located and probably additional field mapping. Then in some cases the pre-mine surface would need to be reconstructed. It is our contention based on the geology and footprints that this approach would not significantly change the proposed weightings, and would delay the program by at least one field season (a year). Furthermore, whether the Meade Peak is given an 18 percent or 22 percent weighting, the final net background concentrations are not likely to be significantly different enough to justify the delay in the implementation of the SAP.*

The parenthetical “up to 20 percent” was a misstatement, because there are locations where because of the pit and waste dump configuration, it was likely significantly greater than 20 percent. Up to 20 percent will be replaced with “approximately 20 percent”.

SC-8. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives.** Identify the proposed background locations here.

P4 Response (SC-8): *The revision will be made as requested.*

SC-9. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives, item 1.** The text states: “Collection of gamma measurements, through GPS-based gamma surveys, within a selected background reference area that through correlation studies (Objective 4 below) can be used to predict total uranium (mg/kg) and Ra-226 (pCi/g) concentrations in soil...” The presence of other gamma-emitting radionuclides, most notably K-40 but also Th-232 and its daughters, could make the correlation of gamma measurements to U and Ra-226 difficult to impossible. Explain how the SAP intends to determine the influence of these other radionuclides on this correlation (in item four it is only stated that these data will be used to evaluate gamma abnormalities). For example, if the background area has elevated K-40 relative to the Sites, then a correlation of Ra-226 to gamma measurements at the background areas would underestimate the amount of Ra-226 at the Sites (and vice versa).

P4 Response (SC-9): *The sentence will be revised as follows (new text underlined): “The gamma spectroscopy laboratory analysis also will yield potassium-40 (K-40) and thorium-232 (Th-232) concentrations in soil, which may be useful in evaluating anomalies in the spatial or frequency distribution of gamma count rates; and trends in the correlations between radionuclide concentrations and gamma emissions and therefore exposure rates.” This change also was added to the last bullet in Section 1.2.2; the last sentence of the subsection titled “External Exposure” in Section 2.2.2; and the second sentence of the second paragraph of Section 4.6 of the Field Sampling Plan.*

SC-10. **Section 1.2.1, page 1-5, Background Area(s) – Activities/Objectives, item 2.** The text states: Collection of radon flux measurements (i.e., radon release rates from soil surface measured as an activity per unit area and time). The flux measurements will be the basis to predict background radon air concentrations and for the calculation of background risks...” One definition of TENORM is radioactivity that has become more bioavailable due to human activity. This would include enhanced radon releases due to mining the ores. Explain if the radon flux measurements taken over Site wastes will be directly compared to the background radon flux measurements to evaluate this potential?

P4 Response (SC-10): *See response to comment GC-3. As stated in Section 3.3., the radon flux measurements will be used to estimate radon concentrations using published methods. These concentrations will be incorporated into the Site and background risk estimates to determine total and incremental risk. No revisions to the text are warranted.*

SC-11. **Section 1.2.2, page 1-6, On-Site – Activities/Objectives, item 1.** The text states: “1) Collection of gamma measurements, through GPS-based gamma surveys, focused on the source areas (waste rock dumps) within the P4 Sites that: (a) can be used to select sample locations to estimate the maximum and range of uranium (thus Ra-226) concentrations...” The implied assumption in this statement is that U and Ra-226 are in equilibrium. This contradicts the other stated study question of trying to determine whether or not the U daughters are in equilibrium. Please explain and revise as appropriate.

P4 Response (SC-11): *Existing information indicates that the uranium series is in secular equilibrium. There is no contradiction in the SAP, given that one of its objectives is to confirm whether this observation is valid.*

SC-12. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model).** The text states: “As a result, the rock (ore) with the most elevated uranium concentrations ends up in the slag material after the ore is processed at P4’s processing facility in Soda Springs, Idaho, and is not returned in any significant volume to the Sites (a small volume of slag is stored at the Ballard Shop Area for use in road repair).” Will the site characterization study include an evaluation of whether the returned slag qualifies as TENORM in the storage area and the roads repaired with this material? See also general comment above about the need to refine ARARs during the FS.

P4 Response (SC-12): *See response to comment GC-3.*

SC-13. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-4, 1st incomplete sentence and paragraph:** The text states that the typical waste rock dumps and backfills are comprised of the upper, middle, and lower waste shale beds of the Meade Peak Member along with portions of the Dinwoody and Wells Formations. The waste rock also contains Rex Chert and the Cherty Shales which also have a much lower gamma radiation response than the ore-bearing units. Please revise accordingly.

P4 Response (SC-13): *The text will be revised to include the Rex Chert and Cherty Shales of the Phosphoria Formation.*

SC-14. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-4, last paragraph.** The text provides an example of a “typical” mine configuration to better understand the distribution of ore to waste in a typical cross-section. The distribution of ore to waste depends primarily on the structural geology which is extremely different among phosphate mine sites in southeastern Idaho due to the complex regional geology. Please clarify that there can be substantial structural variation between mines and the main purpose of this sectional view is to illustrate the fact that background samples have not been collected from soils overlying the Phosphoria Formation.

P4 Response (SC-14): *The purpose of the text in Section 2.2.2 and Figure 2-2 is to illustrate the relationship of a typical mine plan and geology for the P4 Sites as well as the relative location of previous background samples. The configuration shown is typical for a majority of the mines in SE Idaho where mining occurs on the limbs of folds. The Ballard Mine is actually an example of one that is not and is more structurally complex. The text in Section 2.2.2 and Figure 2-2 correctly describe and show a typical configuration and no changes are warranted.*

SC-15. **Section 2.2.2, page 2-4, Conceptual Model (Lithogeochemical Conceptual Model), page 2-5, 1st paragraph, last sentence:** The issue of site risk is not whether uranium and other COPC concentrations in soils on the Sites may be lower than over the native Phosphoria Formation ore sequence, the issue is whether the impacts from mining such as waste rock

dumps, backfilled pits and unreclaimed pits, in relation to existing Site conditions, pose a risk to human health or the environment. Revise accordingly.

P4 Response (SC-15): *As stated in the SAP (see Table 2-1), a primary study question is to develop accurate on-Site incremental and total risks (see P4 response to GC-2). However, the objective of the text in Section 2.2.2 is to describe the conceptual model, not pose the Data Quality Objectives (DQOs). The text in Section 2.2.2, page 2-4 is accurate as written and no revisions to the SAP are required.*

SC-16. Section 2.2.2 Conceptual Model (Risk Assessment Conceptual Model), page 2-5, 3rd bullet. The text states: “Exposure pathways – Direct exposure to gamma radiation, inhalation of radon in indoor air, and uptake of radiological COPCs from soil into fruits and vegetables grown in affected soils.” Is this intended to be a complete list of exposure pathways? If so, there are missing exposure pathways (e.g., inhalation of dust and direct ingestion of soil could factor into a recreational hiker/camper scenario) that should be acknowledged. Explain why these potential pathways are not considered important. For example, were they not included because the relative exposure (and risk) are insignificant compared to the other identified pathways (direct exposure to gamma radiation, inhalation of radon in indoor air, and uptake of radiological COPCs from soil into fruits and vegetables grown in affected soils)? Revise accordingly. Also, considering these are potentially complete exposure pathways, the significance of excluding them will need to be described in the uncertainties. Also, there is no mention of surface water or groundwater pathways. Clarify what data are available to support that these other major media are not potentially contaminated with radiogenic material and therefore need not be studied further.

P4 Response (SC-16): *No, the human health exposure pathways listed in the 3rd bullet are not intended to be a comprehensive listing of complete exposure pathways for human receptors; rather, they represent those exposure pathways that are assumed to contribute most significantly to risk for a hypothetical future residential receptor. For other potentially complete exposure pathways and media, uranium didn’t contribute significantly to human health risks in the HHRA for the Ballard Mine (MWH, 2013b). Specifically in regard to the recreational camper/hiker, cancer risk and noncancer hazard estimates for this receptor were below 1E-06 and 1, respectively, in the HHRA for the Ballard Mine (MWH, 2013b). Please note that concentrations of uranium weren’t significantly elevated in surface water or groundwater, and uranium didn’t contribute significantly to human health risks for these media in the HHRA for the Ballard Mine (MWH, 2013b); therefore, P4 is not proposing to collect radiological data for these media. Finally, P4 only intends to quantitatively evaluate radiogenic risks for a hypothetical future resident and not the other receptors listed in the 4th bullet. Text in Section 2.2.2 will be revised to clarify the above.*

SC-17. Section 2.2.2, page 2-4, Conceptual Model (Risk Assessment Conceptual Model), Page 2-5, 4th bullet: The text makes reference to livestock and wildlife receptors which have not been mentioned earlier in the document. Clarify if the proposed new data are planned for use in both the HHRA and ERA and if so, exactly how for the ERA. Also, if the data are proposed for use in the ERA, this needs to be made clear in the early sections of the document along with the discussions of the planned use of the data in the HHRA.

P4 Response (SC-17): *Uranium didn't contribute significantly to risk for livestock or wildlife in the ecological risk assessment (ERA) for the Ballard Mine (MWH, 2013b); therefore, the radiological data will not be evaluated in the livestock risk assessment (LRA) or in the ERA to be prepared for the Enoch Valley and Henry mines. The 4th bullet will be revised to clarify this point.*

SC-18. **Section 2.2.2, page 2-4, Conceptual Model (Risk Assessment Conceptual Model), page 2-6, 1st paragraph:** Revise to clarify that for those portions of Henry and Enoch Valley Mines on either National Forest System or Bureau of Land Management lands, the federal land management agencies have determined that a future residential risk scenario is unlikely and as such, will not be included in the HHRA for those portions of the Sites.

P4 Response (SC-18): *Please refer to our response to GC-8 in regard to the evaluation of human health risks for residential receptors.*

SC-19. **Section 2.2.2 Conceptual Model (External Exposure), page 2-6, 1st paragraph, last sentence.** Text states: "Gamma rays from the radioactive decay of Ra-226 have the potential to deliver a radiation dose to occupants of structures overlying soils containing U-238." Technically the external dose depends heavily on the decay products of Ra-226. Revise to read "Ra-226 and its daughters."

P4 Response (SC-19): *The text will be revised as follows: "Gamma rays from the radioactive decay of Ra-226 and its progeny have the potential to deliver a radiation dose to occupants of structures overlying soils."*

SC-20. **Section 2.2.2 Conceptual Model (External Exposure), page 2-6, 2nd paragraph, 6th sentence.** Text states: "Note that the concentrations of Ra- 226 in soil can be estimated from concentrations of U-238, assuming (1) secular equilibrium is present in the decay series or (2) consistent ratios of the two are observed, if secular equilibrium is not confirmed in this investigation." Given the material is waste rock that has not been processed, the only reason that disequilibrium between U and Ra-226 should exist is if Ra is being preferentially mobilized relative to U. If this is the case, such preferential leaching may not be consistent between the different rock formations, or between the proposed background areas and the sites. How will the study differentiate the results to determine whether disequilibrium (if it exists) is different between these variable areas? What will be done if disequilibrium is discovered in an inconsistent ratio between rock formations and sites, especially if disequilibrium is found in the waste rock at the sites but not found in the similar rock formations at the background site?

P4 Response (SC-20): *P4 recognizes that supplemental sampling and analysis –out of the scope of this investigation-- may be required, or appropriate conservative assumptions made in the risk assessment, if there is disequilibrium and/or inconsistent ratios observed in the uranium series between geologic formations, Sites, and background locations.*

SC-21. **Section 2.2.2 Conceptual Model (Radon), page 2-7.** Text states: “Because of the more permeable nature of waste rock compared to pre-mining rock and soil, radon flux could be less inhibited in waste rock (i.e., freer gas movement).” Would this enhanced radon flux cause the waste rock to be defined as TENORM? Please define the direct study question that is being proposed relative to this possibility. See also general comment above about the need to refine ARARs during the FS.

P4 Response (SC-21): *See response to comment GC-3.*

SC-22. **Section 2.2.2, Background Locations and Selection, page 2-7.** The text states that “The character the ore-bearing Phosphoria Formation does not change significantly over a few miles....” Please clarify what “character” means in the context of the proposed work which is to collect representative background soils samples for COPC concentrations in addition to radiological surveys. The notable geochemical variability of the lithologic units of the Phosphoria Formation is well documented in the various phosphate mine EISs. Subsequent text states “The Phosphoria geology and geochemistry is not expected to change significantly over a scale of a few miles.” Please provide references to support this statement. As mentioned earlier in the text, faulting in the Western Phosphate Field occurred after ore formation. Structural folding also occurred after ore formation. Both structural processes result in associated geochemical and mineralogic alterations in nearby stratigraphic units. Additionally, weathering of the Phosphoria Formation, and more specifically the Meade Peak Member, results in substantially altered COPC concentrations between weathered versus un-weathered shales. The differential weathering combined with the varying complex structural settings of the Meade Peak Member does result in significantly different geochemistry over relatively short distances (less than a few miles). Additionally, the spatial distance between the P4 CERCLA sites and the proposed background location is approximately 10 miles which is more than a “few”. Revise accordingly to reflect this information.

P4 Response (SC-22): *See the discussion associated with comment GC-1. It is clear that the best background samples would have been samples collected from the actual mine site prior to mining, such as those collected as part of baseline studies for the current permitting process (e.g., Blackfoot Bridge). However, because these data are not available, similar phosphate ore areas (i.e., analogs) needed to be located and sampled. The paper by Perkins and Piper (2004) does provide a general overview of the variability spatially within the Phosphoria basin (Utah, Wyoming and Idaho), but mostly deals with depositional differences on a basin-wide scale. It is notable that the geology between deposits is more variable in an east-west direction than in the north-south direction. Brought down to the basic conclusion, the selected analogs are the best that are available given a nearby location, similarity, and knowledge about the geology of the location. Data from these analogs is preferable to not having data from the soils overlaying a significant portion of the pre-mine landscape. The inclusion of two background areas in the study will help quantify some of the variability between deposits.*

SC-23. **Section 2.2.2 Background Locations and Selection, page 2-7.** Text states: “The character the ore-bearing Phosphoria Formation does not change significantly over a few miles, except

possibly along the basin edges, in contrast to other types of ore deposits.” Is there data available to directly or indirectly compare the pre-mined concentrations of U in the ores mined from the Sites relative to the ores in the proposed background sites? This type of information may be useful in evaluating whether the proposed reference areas are representative of the conditions near the sites.

P4 Response (SC-23): *See response to comment SC-22.*

SC-24. Section 2.2.2 Background Locations and Selection, page 2-8, 1st incomplete paragraph.

The text states “For this reason, locations immediately adjacent to the Sites are not available for soils overlying all geologic formations.” The text goes on to state that “Ideally, the background area is one that has been identified for future mining...” The A/T disagrees with this statement and it should be revised something to the effect of “Ideally, background samples should be collected from nearby undisturbed areas with similar geologic and topographic configurations.” Whether an area has been designated as suitable for future mining is a secondary consideration.

P4 Response (SC-24): *We disagree in part. The statement, “Ideally, background samples should be collected from nearby undisturbed areas with similar geologic and topographic configurations” is certainly the key consideration. However, if the location has been identified as having an ore reserve that is suitable for mining, then it is obviously of similar geologic and geochemical character to those locations that have already been mined. In addition, a conceptual mine design also has been at least considered or fully developed (e.g., Blackfoot Bridge) so that the geology of these proposed background areas is more fully assessed. This is preferable to an area where some surface mapping has been conducted at a regional level. The text will be modified as follows:*

“Ideally, the background area is one that has been identified for future mining, is nearby, and has the characteristics of the Sites with similar geologic and topographic configurations. The identification of the area for future mining helps provide that the location or locations have been geologically characterized to a level that provides addition assurance of similarity and that the requisite similarity of geologic units (including ore quality Phosphoria Formation) are present. Both of the locations selected for this study have been identified for future mining and have ore grade mineralization within the Phosphoria Formation.”

Furthermore, it is P4’s position, that the selected locations are nearby given the phosphate field geology, and the size of the phosphate basin (135,100 sq. miles) compared to distance between the proposed background areas and the P4 Sites.

SC-25. Section 2.2.2 Background Locations and Selection, page 2-8, 2nd paragraph. The text states “These areas also have the advantage that the geology is well understood through mapping at the surface and in the subsurface by drilling.” This implies that exploration drilling at both background locations has taken place. Revise text to specifically say whether or not exploration drilling has been performed at both background locations. If exploration drilling has taken place, present any data/information that might support the premise that the

background areas and the Sites have similar geology, including any geochemical data that may support the similarities.

P4 Response (SC-25): *Both background sites have been drilled and the geology studied. The Blackfoot Bridge data has been presented in various baseline studies and permitting documents and are publically available as the result of the NEPA process. The Caldwell Canyon Site has been explored focusing on the ore location. Additional data including drill logs, cross sections, and typical stratigraphic columns (if available) will be provided in the revised work plan.*

SC-26. **Figure 2-4:** It appears that at least one of the proposed radiological survey areas is planned on National Forest System lands at Enoch Valley Mine. Since radon exposure will not be included in the HHRA for FS lands, it is recommended that this location be removed from the plan.

P4 Response (SC-26): *The three survey areas for on-Site radon sampling discussed in the SAP have not been identified. They will be based on GPS-based gamma surveys performed across the waste rock dumps at each of the three P4 Sites. It is anticipated that between the three P4 Sites, there will be three radon survey areas based on the GPS-based gamma survey (low, medium, and high gamma count rates). Figure 2-6 Example On-Site Sampling Approach at Enoch Valley Mine depicts a “hypothetical” survey unit at the Enoch Valley Mine, but the location of this survey unit may be at another P4 Site or another part of the Enoch Valley Mine. Figure 2-6 figure title will be revised from “Example” to “Hypothetical”.*

SC-27. **Section 3.0 Sampling Design – Background and On-Site Areas, page 3-1.** Text states: “The data needed to evaluate risks from these parameters are external gamma, radon flux, radiation dose, and soil concentrations of total uranium and daughters products (e.g., Ra-226).” Delete “radiation dose” from this list. It is a calculated value derived from the data collected, and no direct measurement (e.g., environmental TLDs) is being proposed for this parameter.

P4 Response (SC-27): *The text will be revised from “radiation dose” to “exposure rates”.*

SC-28. **Section 3.1 Background Area Sampling Approach, page 3-3.** In step 3, the text states, “Select a single line of transect across the Background Area that is oriented perpendicular to the geologic units (based on geology and information from Steps 1 and 2) that will be used to collect samples in Steps 4 and 5, below.” Explain what are the specific criteria that will be used to judge which line of transect over another, and why are they relevant to ensuring that the background transect represents the pre-mined conditions of the Sites?

P4 Response (SC-28): *The criteria used to select one of the transect lines for background sampling will be based on several factors including visual and radiological evidence of geologic contacts as well as accessibility. As stated in Section 4.3 of the Field Sampling Plan “The line will be chosen in the field by the FTL based on (1) the gamma survey results, which should clearly show the Meade Peak Member’s upper and lower contacts and (2)*

favorable field conditions including: readily identifiable changes in the dominant formation (i.e., formation contacts), vegetation coverage (areas devoid of trees/scrubs would be desired), accessibility by all-terrain vehicles, etc. The transect survey lines crossing areas that are overly steep or have bedrock outcrops would be avoided.” Each of the background transects should be representative of the four geologic units most commonly mined or covered with mine waste rock of the P4 Sites and all transects. The text will be clarified to include the criteria used to select the background transect for sampling.

SC-29. **Section 3.2, On-Site Sampling Approach, page 3-5, step #2.** Based on the size of the hypothetical survey area shown in Figure 2-6, each of the three survey areas could encompass most, if not all of an individual mine. Provide further explanation of potential criteria that will be applied to determine the size of a survey area. The text also implies that the survey areas will not necessarily be distributed between the three mines; that is, the three survey areas could end up being on just one or two of the mines. Clarify if the survey areas may or may not include all three mines.

P4 Response (SC-29): *The size and location of the survey areas will result from the GPS-based gamma surveys. The survey areas will span the range of the gamma count rates (low, medium, and high). For example, an area of similar low gamma count rates (e.g., one or two similarly reclaimed waste rock dumps) will be identified and divided into 15 approximately equal areas. The survey areas may or may not include all three P4 Sites as the commenter cites. The objective is include the range of radon flux based on the gamma count rates. Section 3.2 will be revised to clarify this objective.*

SC-30. **Section 3.3.4, Correlation Studies, page 3-9, paragraph 1 (partial), line 1.** Confirm a minimum of 20 correlations as it seems that there will be 20 samples in the background areas (4 geologic units X 5 samples/unit) plus 10 On-Site samples which equate to a minimum of 30 samples for the correlation study.

P4 Response (SC-30): *There will be 5 correlation samples collected in each of the two background areas for a total of 10 correlation samples from the background areas plus 10 On-Site samples for minimum of 20 correlation samples. The text will be clarified to emphasize this fact.*

SC-31. **Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-10.** Text states: “The background soil samples collected for COPC analyses from soil overlying each of the geologic formations during this sampling effort will be evaluated consistent with the statistical methods and procedures...” Given the number of confounding factors associated with the proposed calculation of a background concentration, how will the calculation of a UCL95 of the mean and USL95 account for:

- Use of composite samples instead of grab samples
- The effects of eliminating samples as “outliers”
- The uncertainty of proportions of the Sites represented by different geologic formations

- The potential difference between the ore concentrations in the background areas and the ore concentrations at the Sites

P4 Response (SC-31): *Please note that composite samples may be used in risk assessment as long as they meet acceptable QA/QC and data usability requirements. The use of composite sample data, like incremental sampling data, results in lower variance which, in turn, decreases the “high bias” in statistical parameters that may result from extreme values. In regard to the elimination of outliers, this practice also tends to reduce variance in datasets which, in turn, tends to reduce the “high bias” in statistical parameters that may result from inclusion of outliers. An attempt has been made to collect an equal number of background samples from each geologic unit. The sample results from each of the different geologic units will be weighted to account for the proportion of each unit at the mine sites. Please refer to P4’s response to SC-34, below, regarding the uncertainty in this approach and the additional statistical information that will be derived to help address this uncertainty. Finally, there will always be a potential for differences in ambient concentrations between a site and a reference area. This potential difference will be minimized by the careful selection of an appropriate reference area that represents as close to the same geological characteristics as the P4 Sites.*

SC-32. Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-11, 1st paragraph:

Provide reference’s to project documents that include the borelogs and cross-sections in order to support and illustrate that the geologic sequence and pit construction is similar to Ballard, Henry, and Enoch Valley Mines as depicted in Figure 2-2.

P4 Response (SC-32): *See the response to comment SC-25.*

SC-33. Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-11, bullets. In

response to previous agency comments regarding the distribution of background samples across the various geologic formations at the mines, P4 has attempted to estimate the typical affected footprint of the three mines and has broken this down further by geologic formation. This is fraught with potential error because the ratios will vary from mine to mine. See also specific comment below.

P4 Response (SC-33): *This was discussed in the response to SC-7. There is also significant error in calculating the numbers based on the mine configurations. So opposed to developing three weighting schemes with possible significant error, P4 has elected to utilize a common weighting scheme based on the observed geologic relationships. This has an advantage in that it is simpler to apply across all the Sites and especially for Ballard where the pre-mine geology is complex and hard to define.*

P4 contends that these data are needed to provide a more representative background, and data collected from the reference background area data analog are better than no data, see response to comment GC-1. For all the reasons stated in the SAP and in this response to comments, the data from the analog sites are expected to be reasonably representative of the pre-mine background and a substantial improvement over excluding data from soils over the Phosphoria Formation from the background data set. It should also be noted that there is

an equal chance that by using the data from the analog sites, that the data could be biased slightly higher or lower than the actual pre-mining background at the Sites.

SC-34. **Section 3.3.5, COPC Soil Sampling in Background Areas, page 3-12.** In response to previous agency comments regarding the distribution of background samples across the various geologic formations at the mines, P4 has attempted to estimate the typical affected footprint of the three mines and has broken this down further by geologic formation. This is a gross approximation; actual percentages will vary from mine to mine. Furthermore, P4 is proposing to weight the background COPC UCLs of the Mean and USLs based on the relative areas of disturbance of the formations. If available, provide reference to where this approach of weighting subpopulations has been used previously in establishing soils background under CERCLA.

Additionally, from a statistical standpoint, the A/T believes there are inherent concerns regarding this concept, as discussed below.

Calculated UCLs of the mean tend to be closer to the Mean when variability in the results is smaller and when the number of samples is larger. With skewed right data sets, the average of four UCLs of the Mean (using 20 samples) will tend to be higher than the calculated UCL of the Mean for the combined 80 samples.

Developing a statistically defensible UCL of the Mean for a population is not achieved by averaging UCLs of the Mean for subsets of that population. One does not necessarily expect such an average to provide an appropriate 95% UCL of the Mean for the overall population. A project team might find that such an averaging approach suits their needs, but they would not be able to present it as a statistical UCL of the Mean.

To investigate how different these approaches can be, an initial effort with randomly generated normal data was reviewed with the ratio of the average of four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples) ranging from about 1.06 to 1.14 for coefficients of variation (CoVs) ranging from about 0.3 to 0.9. A CoV is simply the standard deviation divided by the mean. Thus, it offers a convenient measure of the relative variation present in a data set. Noting that increasing CoV with normally distributed data (a symmetrical, bell shaped distribution) lightly increased the ratio of the average of four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples), promoted curiosity as to how much the ratio might increase if the data set were skewed right as seen so frequently in environmental data.

To pursue that concern, eight sets of data for each of three relative skewness categories from randomly generated gamma distribution data sets provided the following results. Each set of data included four subsets of 20 results (80 overall results per data set). Gamma distributed data can range from symmetrical to very skewed. With these data the UCLs of the Mean were calculated using ProUCL.

Evaluation of Randomly Generated Gamma Distribution Data Sets

Relative Skewness	Ratio of Average of Four UCLs of the Mean (20 samples each) to a UCL of the Mean (combined 80 samples)
Low	Median Ratio = 1.06 with range of 1.05 - 1.07
Moderate	Median Ratio = 1.20 with range of 1.05 - 1.27
High	Median Ratio = 2.59 with range of 2.01 - 2.88

As can be seen in the table above, when skewness is relatively low, there is only a minor (a few percent) difference between the average of four UCLs of the Mean (using 20 samples) and the calculated UCL of the Mean for the combined 80 samples (as was seen with the normally distributed data). As skewness increases, the difference becomes much more pronounced. The range of CoVs in this randomly generated data set resemble those encountered in actual environmental data. These included calculated CoVs of about 0.2-0.4 for the low skewness category, 0.7-1.4 for the moderate skewness category, and 1.7-3.8 for the high skewness category.

For USLs, the effect of weighting by formation is more complicated than that with UCLs of the Mean. With UCLs of the Mean, we are primarily concerned with the combined data set offering a calculated UCL of the Mean lower than the average of the subset UCLs of the Mean. With USLs and other background threshold values, one would expect some of that, but one would often expect the combined USL to be most dominated by the subset with the highest concentrations. Thus, for some cases, the combined USL would be higher than the weighted USL. There would not be as clear a prediction as to which version would be higher.

Therefore, based on the above analysis, weighting by geologic formation may result in indefensible background statistics. Weighting would likely inflate the UCL of the Mean and could affect the USL in an unpredictable manner. Therefore, the A/T requires that P4 report the following unpooled statistics for each COC for each of the four formations:

- Box and whisker plots
- The calculated UCLs of the Mean
- The calculated USLs

Additionally, the A/T requires that P4 report the following statistics for the pooled data for each COC:

- The weighted values for the 95%UCLs as proposed in the SAP
- The unweighted (combined 80 samples) values for the 95%UCLs

- The weighted values for the 95%USLs as proposed in the SAP
- The unweighted (combined 80 samples) values for the 95%USLs

Together, this information will allow the A/T and P4 make the most informed decisions for establishing final soil background concentrations for the P4 Mines. Revise the work plan accordingly.

P4 Response (SC-34): *Thank you for the detailed analysis of the potential effect of skewness on statistics derived from weighted subpopulations vs. the combined population. We agree that there is potential uncertainty in this approach and we are not immediately aware of a CERCLA site where a similar weighting approach has been used for estimating background concentrations. The P4 Sites and other Idaho phosphate sites are relatively unique in configuration compared to most other CERCLA mine sites we are aware of. Notably, the common geology, strong stratigraphic control on ore location, and presumed associated variations in soil character are unique to this type of deposit. Coal and trona (soda ash) are possible examples of similar ore deposits in the Western U.S.*

It would not be prudent to ignore (and not compensate for) the potential variability in lithology-associated soil chemistry knowing that it exists. What the weighting approach is designed to do is to systematically simulate the condition where a defined footprint of a mine site is sampled using randomly located samples prior to mining. The distribution of those samples should ideally reflect the relative exposure of the geologic units within the pre-mine landscape. However, P4 agrees to prepare box and whisker plots and the additional unweighted statistics that the A/Ts are requesting for comparison purposes.

SC-35. Table 2-1, Step 1, 4th paragraph: The text states that the background samples collected during the RI specifically excluded soils derived from and overlying the Phosphoria Formation. As noted in a previous comment, this is misleading and the term “specifically excluded” should be replaced with “did not include.”

P4 Response (SC-35): *The revision will be made as requested.*

Appendix A: Field Sampling Plan

A-SC-1. Section 4.3, GPS-Based Gamma Survey – Background and On-Site, page 4-4, bullets. Add statement clarifying if the GPS gamma measurements are continuous or if data are collected at intervals.

P4 Response (A-SC-1): *The text will be revised to include the following sentence at the end of the first paragraph in Section 4.3: “The gamma count rate measurements and associated differentially-corrected geopositions will be recorded every second.”*

A-SC-2. Section 4.3, GPS-Based Gamma Survey – Background and On-Site, page 4-4, last paragraph. Other than defining the upper and lower Meade Peak contact, describe how, if at all, the gamma reading may affect the decision as to where the transect will be located; e.g., will generally higher or lower gamma readings overall be a determining factor?

P4 Response (A-SC-2): *Both visual and radiological evidence will be used to determine the contact between geologic units (e.g. lower gamma survey readings over the Wells Formation compared to the Meade Peak). However, lower or higher readings will not be used to determine which transect is selected for background sample collection. As noted in the text, favorable field conditions and accessibility will also play a role in selecting the transect.*

- A-SC-3. **Section 4.4, Radon Flux Measurements, page 4-5, paragraph 2, line 2.** Explain what is meant by a “right circular cylinder” as this reader is unfamiliar with such.

P4 Response (A-SC-3): *The text will be revised to delete “right circular” from the FSP.*

- A-SC-4. **Section 4.4.2, On-Site, page 4-6, bullet #3.** Explain how the point will be randomly selected for placement of the radon canister; e.g., will the x and y coordinates be generated by a random number generator?

P4 Response (A-SC-4): *The text will be revised to add the following text to the first bullet of Section 4.4.2: “The measurement locations will be sited using a triangular, systematic grid with a random start point using the most current version of Visual Sampling Plan.”*

- A-SC-5. **Section 4.6.2, GPS-Based Gamma Surveys and Composite Soil Sampling, page 4-10, 1st paragraph, last sentence.** Explain if “along 5-ft transects” means the transects will be 5 ft in length or 5 ft spacings.

P4 Response (A-SC-5): *The text will be clarified to state that the transects are spaced 5-ft apart.*

- A-SC-6. **Section 4.8, Equipment Decontamination, page 4-11, bullet 1, sub-bullet 3.** Delete “or distilled”. Distilled water should not be used in the decontamination process consistent with Section 2.2.6 of the QAPP.

P4 Response (A-SC-6): *The text will be revised as requested.*

- A-SC-7. **Section 5.1, Sample Designation, page 5-2, bullet 8.** This reader is not sure how the blind duplicate remains “blind”. Possibly rewording of the language will help. Revise accordingly.

P4 Response (A-SC-7): *The text will be revised to indicate that the sample identifier is used to represent “duplicate or replicate samples.” The word “blind” will be removed.*

- A-SC-8. **Section 5.1, Sample Designation, page 5-2, paragraph 1.** The example of “**1407-MBF-RC01-SS**” is inconsistent with the unique identification number explained above as **SS** is not mentioned under **c**. Rectify.

P4 Response (A-SC-8): *The section will be revised to include “SS” designation in the example.*

- A-SC-9. **Section 5.2, Sample Handling and Shipping, page 5-3.** This section seems to be mislabeled as the list includes items above and beyond what is needed for shipping and handling. Also, include in the list necessary field equipment such as auger, trowel, and bowl, and miscellany such as pens, extra batteries. Revise accordingly.

P4 Response (A-SC-9): *The section will be titled “Field Equipment, Sample Handling, and Shipping”.*

Appendix B – Quality Assurance Project Plan

General Comments

- A-GC-1. Overall, the metals portion of the QAPP is appropriate. The methods and QC checks are detailed and the example validation reports provide sufficient information to discern the reasons for individual data qualification. No changes are needed.

P4 Response (A-GC-1): *Comment noted.*

- A-GC-2. EPA method 6020 was not shown for analysis of Boron, Molybdenum & Uranium, but appears to have been adequately covered in the QC tables and Lab MDLs. No changes are needed.

P4 Response (A-GC-2): *The only place that these analytes are not listed in the QAPP are in the LDC report for Spike Sample Analysis and only those analytes that do not comply are listed. P4 is unsure as to what part of the QAPP the reviewer is referring to. However, as the commenter notes “no changes are needed.”*

Specific Comments

- A-SC-10. **Section 1.4.4.1, Precision, page 1-8, paragraph 2, line 3.** Explain what a “report of investigation” is. This term is also used in several subsequent sections.

P4 Response (A-SC-10): *The report of investigation referred to whether the data were used in the RI and FS Reports for either the Ballard, Henry or Enoch Valley Mines as these are all separate reports. The QAPP text will be revised to state the applicable P4 Sites RI/FS document.*

- A-SC-11. **Appendix B, SOP Soil-1, Section 3.1, Drying.** Text should indicate either the reference method for performing the initial percent solids or the drying temperature (e.g., 105°C)

that went in to the determination. Either ASTM D2216 or the CLP ISMO1.2 SOW may be used as suitable references.

P4 Response (A-SC-11): *The text will be revised to reference ASTM D2216.*

Editorial Comments

General Editorial Comments

Be consistent on whether the word data is singular or plural. Plural is preferred.

Change “Roskelly” to “Roskelley”.

Specific Editorial Comments

1. **Figure 2-4, page 2-11, Sampling Approach, bullet 6)b, line 1.** Delete the second “soil sample”.
2. **Section 3.1, page 3-3, bullet 3, line 21.** Change “overly” to “overlie”.
3. **Section 3.2, page 3-5, bullet 1), line 5.** Change “has” to “have” for subject-verb agreement.
4. **Section 3.2, page 3-6, bullet 4)b, line 2.** Delete the second “soil sample”.
5. **Section 3.3.5, page 3-10, paragraph 1, line 1.** Change “Area” to “Areas”.
6. **Section 3.3.5, page 3-11.** There are two pages labeled 3-11, one before Figure 3-1 and one following Figure 3-2. Correct accordingly.
7. **Table 2-1, Step 1, page 2, paragraph 1 (partial), line 10.** Insert “is” between “risk” and “appropriately”.
8. **Table 2-1, Step 2, page 3, Estimation statement, paragraph 1, line 5.** Change “portion” to “portions”.
9. **Table 2-1, Step 2, page 4, Estimation statement, paragraph 1, line 2.** Delete the second comma.
10. **Table 2-1, Step 2, page 4, Estimation statement, paragraph 1, line 4.** Delete the period following the question mark.
11. **Table 2-1, Step 3, page 4, bullet 2, line 2.** Change the comma to a period.
12. **Table 2-1, Step 4, page 5, bullet 1.** Add a period to the end of the bullet.
13. **Table 2-1, Step 5, page 6, paragraph 3, line 1.** At “randomly” what?
14. **Table 2-1, Step 5, page 6, paragraph 4, line 5.** Change “previous” to “previously”.
15. **Table 2-1, Step 5, page 6, paragraph 5, line 4.** Delete the first “and”.
16. **Table 2-1, Step 5, page 6, paragraph 5, line 5.** Insert “will be” between “samples” and “collected”.
17. **Table 2-1, Step 5, page 7, paragraph 1 (partial), line 2.** Change the semi-colon to a comma.
18. **Table 2-1, Step 5, page 7, paragraph 4, line 1.** Identify what the “15 randomly selected” are, presumably sites.

19. **Table 2-1, Step 5, page 7, paragraph 5, line 3.** Delete “and”.
20. **Table 2-1, Step 5, page 7, paragraph 5, line 4.** Change to “. . . made; and soil samples will be collected . . .”
21. **Table 2-1, Step 5, page 7, paragraph 5, line 7.** Change the semi-colon to a comma.
22. **Table 2-1, Step 6, page 8, paragraph 1, line 5.** Change to “Background”.
23. **Table 2-1, Step 7, page 8, paragraph 1, sentence 1.** This sentence reads awkwardly, should perhaps “are based on” be inserted between “design” and “knowledge”? Revise accordingly.

Appendix A – Field Sampling Plan

24. **Section 3.1.2, page 3-3, bullet 3 (partial), line 10.** Change “overly” to “overlie”.
25. **Section 3.2.2, page 3-5, bullet 1, line 5.** Change “has” to “have” for subject-verb agreement.
26. **Section 4.1, page 4-1, section title.** Change to “Site Access, Logistics, and Safety”.
27. **Section 4.1, page 4-1, paragraph 1, line 4.** Delete “at”.
28. **Section 4.1, page 4-1, paragraph 2, line 1.** Delete the first “stored”.
29. **Section 4.2.1, page 4-2, paragraph 1, line 3.** Change to “Wells Formation,”.
30. **Section 4.2.1, page 4-2, paragraph 1, line 5.** Change “area” to “areas”.
31. **Section 4.4, page 4-5, paragraph 2, line 9.** Change “are” to “is” for subject-verb agreement.
32. **Section 4.5, page 4-7, paragraph 4, line 4.** Change to “. . . three strata sampled and a total . . .”
33. **Section 4.5, page 4-7, paragraph 5, line 3.** Change to “accomplish” to “accomplished”.
34. **Section 5.1, page 5-2, sub-bullet 4.** Tab “Caldwell Canyon Background Area” over.
35. **Section 5.1, page 5-2, bullets 4-7.** Indent “DW”, “MP”, “RC”, and “WF” as sub-bullets.
36. **Section 5.1, page 5-2, bullet 8.** Reword the language inside the parentheses as it is confusing to this reader.

Appendix B – Quality Assurance Project Plan

37. **Section 1.4.2, page 1-2, paragraph 1, line 5.** Change to “. . . analysis; laboratory-specific . . .”
38. **Section 1.4.2, page 1-2, paragraph 3 (Background Investigation), lines 2&3.** Change to “(1) the Meade Peak, (2) the Rex Chert/Cherty Shale Members of the Phosphoria Formation, and (3) the Wells Formation.”
39. **Section 2.7.3, page 2-13, paragraph 2, line 1.** Change to “3rd-party”.
40. **Table 2-1.** Change to “≤ 6 °C” in the Preservation column for both occurrences.
41. **Table 2-1, footnotes.** Change to “degrees”.

Attachment B, SOP SOIL-1

42. **Section 2.0, Target Analytes, page 1, paragraph 1, line 1.** Change “19” to “20” based on target analytes listed in Table 2-1.

P4 Response (Editorial Comments): *These editorial comments will be incorporated into the next versions of the SAP, FSP, and QAPP.*

References

- USEPA. 2003. *Guidance for Obtaining Representative Laboratory Analytical Subsamples From Particulate Laboratory Samples*. EPA/600/R-03/027. November.
- USEPA. 2013. *ProUCL Version 5.0.00 Technical Guide Statistical Software for Environmental Applications for Data Sets with and without Nondetect Observations*. EPA/600/R-07/041. September.